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Bonneville Lock and Dam
Columbia River Basin, Washington - Oregon

Hydraulic Evaluation of Lower Columbia River Adult Bypass Systems (HELCRABS)

Bradford Island 'B' Branch Adult Fishway Evaluation



July 2004

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List Of Acronyms

ADV	- Acoustic Doppler Velocimeter
AWS	- Auxiliary Water Supply
BiOp	- 2000 Biological Opinion
DM	- Design Memorandum
EC-HD	- Hydraulic Design Section of Engineering and Construction Branch of Portland District Corps of Engineers
FCRPS	- Federal Columbia River Power System
FG	- Diffuser Gate Designation (normal usage would be Diffuser Gate FGX-XX)
FPP	- Corps of Engineers Fish Passage Plan
FPOM	- Fish Passage Operations and Maintenance
FV	- Fish Valve
GUI	- Graphical Users Interface
HELCRABS	- Hydraulic Evaluation of Lower Columbia River Adult Bypass Systems
MOP	- Minimum Operating Pool
NGVD29	- National Geodetic Vertical Datum of 1929 (vertical datum used for construction of Bonneville Dam)
NHC	- Northwest Hydraulic Consultants
NMFS	- National Marine Fisheries Service
NWP	- Portland District Corp of Engineers
OP	- Operations Division of Portland District Corps of Engineers
RPA	- Reasonable and Prudent Action
SO-SG-2	- Designation for main fixed entrance weir
S0-SG-4(N/S)	- Designation for north sluice gate entrance (N for North and S for South)
SO-SG-7	- Designation for side fixed entrance weir

Executive Summary

The purpose of the “Hydraulic Evaluation of The Lower Columbia River Adult Bypass Systems” (HELCRABS) study program is to assess the performance of each lower Columbia River adult passage system with respect to adult fisheries criteria. Specifically, the HELCRABS study program encompasses the eight fishways that bypass upstream migrating salmonid adults around Bonneville dam, The Dalles dam, and John Day dam. The HELCRABS program was created in response to questions and directives regarding fishways in the National Marine Fisheries Service (NMFS) 2000 Biological Opinion for the Columbia River (BiOp). In the BiOp, Operations Division of the Portland District (OP) is to furnish NMFS evaluation reports for each Fishway by the end of 2003. Each report shall contain (a) an assessment of the existing performance of a fishway with respect to hydraulic fisheries criteria, (b) recommended operational changes to optimize the fishway performance, and (c) recommendations for structural changes if adequate performance is unattainable with the existing fishway system. OP tasked the Hydraulic Design Section (EC-HD) to conduct this hydraulic study in coordination with the three projects. The HELCRABS program is scoped to proceed in three phases: (1) the evaluation reports for OP, (2) the field data verification and correction/refinement of the numerical models used to conduct the evaluations, and (3) linking the models to fishway control systems so that operations can be set in the project control rooms. This report describes the results of the evaluation of the Bonneville Bradford Island B Branch Fishway.

The Bradford Island B Branch Fishway is one of four ladder systems at the Bonneville Dam complex that provide bypass routes for upstream migrating adults past the dam. This ladder is located on the north shore of Bradford Island and collects fish swimming up the south side of the spillway tailrace channel (see Plates 1 and 2).

This fishway evaluation uses a numerical computer model created to simulate the hydraulic conditions in the Bradford Island B Branch Fishway system. The model was developed by Northwest Hydraulic Consultants (NHC) in 1995-1996 and was calibrated based on limited prototype field data. Since the development of the computer model, several deficiencies or concerns have become apparent (see Section 3.3.2). As part of this detailed evaluation, EC-HD embarked on a plan to verify/correct the model by performing prototype flow measurements and reviewing the program code. The model evaluations verified that field measurements and model corrections had to be done in order to conduct the fishway evaluation. The most pertinent corrections and calibrations to the model were made so that EC-HD could proceed with the fishway evaluation. The correction of remaining deficiencies is less critical and has been deferred until a later phase of the HELCRABS program.

The adult fish passage criteria are the following:

- Head drop across ladder entrance – 1.0 ft to 2.0 ft with 1.5 ft optimum
- Minimum entrance weir submergence – 8.0 ft
- Head over overflow ladder weirs – 1.0 ft (1.3 ft during Shad passage season)

- Channel velocities – 1.5 to 4.0 ft/s with 2.0 ft/s optimum
- Diffuser velocities – less than 0.5 ft/s

The evaluation of the current operation of the existing Bradford Island B Branch Fishway revealed two significant cases where fishway criteria are not met:

- When tailrace levels are less than +11 ft NGVD29 (approximately 16% of the time during the main fish passage season, 1 March through 30 November), the entrance submergence is less than 8 ft.
- For all simulated tailrace levels, collection channel velocities are just at or less than the 1.5 ft/s minimum velocity.

The first criteria conflict is caused by the physical limitations of the system (minimum invert for the entrance openings is elevation +3 ft, NGVD29). The Bonneville tailrace falls below the +11 ft NGVD29 level threshold about 16 % of the time. Only a structural change can improve or correct the submergence problem.

Operational changes can address the second problem with respect to criteria (velocities) for most tailrace levels. The operational change consists of allowing for more flow through the fishway. Proposed operational changes include:

- Open one or two entrance sluice gates(s) over a greater range of tailrace levels, particularly higher (medium) levels.
- Run more open diffusers; large diffusers FG4-29 through FG4-33 will need to be open at a greater range of tailrace levels.

With the proposed operational plan, the channel velocity criteria will be met at all tailrace levels above +9 ft NGVD29. The revised plan should be field tested by the Project before it is recommended to the region for the Corps Fish Passage Plan (FPP). (See Section 5.2 and Plate 6 for details).

Recommended potential alternatives for structural changes include:

- Add picket lead to span across downstream end of fish lock channel.
- Replace entrance sluices gates with a 10 ft wide modulating weir and lower the minimum crest nearer to the existing 2 ft invert.
- Study replacing both the sluice gates and the fixed weir with fixed shaped weirs.

Other more substantial structural alternatives include (a) reducing the width of the collection channel and ladder (to save water), (b) lower the collection channel invert and entrance openings (to at least –1 ft NGVD29) so that the fishway can meet the 8 ft minimum submergence at all tailrace levels (see Section 5.3 for details on alternatives).

In addition, EC-HD recommends that work proceed on Phase 2 and Phase 3 of the HELCRABS study program for this fishway. (Phase 2 of the scope pertains to fixing the numerical model as needed to perform the evaluation; Phase 3 includes model

enhancements, such as better graphical output and model results linked to the project control system.) This will ensure greater model accuracy and allow the project personnel to make greater use of the model.

Section 1: Introduction

The Bonneville Project is located on the Columbia River, 42 miles east of Portland, Oregon at river mile 146. The Bradford Island Adult Fishway consists of two branches; the A Branch that serves the spillway and the B Branch that serves the First Powerhouse (see Plate 1). The A and B Branches share a common counting station and exit section. The B Branch Fishway is located on Bradford Island with an entrance bay at the abutment on the south end of the spillway. This fishway was put into service concurrently with the A Branch Fishway, Cascades Island Fishways and the First Powerhouse in 1938. Over the next four decades, modifications were made to the entrances, Auxiliary Water Supply (AWS) system, diffusers, fish valves, the exit, and the forebay head control system. The last major changes occurred in 1970's with the *Modifications for Peaking* [4].

The HELCRABS is a program developed to respond to the NMFS 2000 BiOp. The BiOp in Section 9.6.1.6.3 Adult Fishway Operating Criteria states, “ The Corps annual fish passage plan stipulates operating criteria for the Federal Columbia River Powers System (FCRPS) hydro project adult fishways. Where these criteria are not satisfied, incremental adverse effects to adult migrants (such as delay) may occur. Actions to enhance compliance with fishway criteria include auxiliary water system assessments and upgrades. Other actions address the issue of inadequate fishway entrance weir submergence during low tailwater elevations”.

The BiOp also states under Reasonable and Prudent Action (RPA) 120: “The Corps shall develop improved conditions for adult fishway main entrances at FCRPS dams so that the best possible attraction conditions are provided for adult migrants, both at the Columbia River hydro projects and the four lower Snake hydro projects (where reservoir elevations are held near minimum operating pool (MOP)). The Corps shall report the findings of fishway entrance flow-balancing investigations in a report to NMFS by the end of 2001¹ and shall continue to work through the Fish Passage Operations and Maintenance (FPOM) group to evaluate and implement, as warranted, structural changes to satisfy fish passage plan fishway entrance criteria”.

Under previous scopes of work in the HELCRABS Program, the Portland District (NWP) contracted NHC to develop computerized numerical models to analyze the hydraulics for adult fishways at NWP Columbia River Dams. Computer models have been developed for Bonneville Dam Fishways (A and B Branches), Cascades Island, Bonneville 2nd Powerhouse, John Day Dam Fishways (North and South), and The Dalles Dam Fishways (North and East). During operation and further review of the model, a number of deficiencies or limitations were identified.

The HELCRABS program scope is currently planned to progress in three phases. This evaluation report is the product of Phase 1. Phase 2 includes field verification

¹ The HELCRABS reports are being prepared for this purpose.

measurements and corrections and refinements to the model. Phase 3 introduces possible long-term plans integrating the model with the project control system. Portions of Phase 2 were completed to ensure an accurate evaluation for Phase 1.

This report documents the evaluation of the Bradford Island B Branch Fishway using the numerical model. Most importantly, recommendations are presented for revised fishway operations so that fish passage criteria will be more closely met. Some structural alternatives to further improve fishway performance are described as well. An evaluation of the numerical model is also detailed in the report including the field verification measurements, the findings on model limitations, the corrections made to the model to conduct the evaluation, and recommendations for future corrections and refinements to the model.

Section 2: Fishway System Features

2.1 Fishway History

The B Branch Fishway originally came on line in 1938. The original three entrances were comprised of adjustable and segmented stop-log weirs: two main 15 ft wide weirs discharging to the west, and one 13 ft wide side weir discharging northward to the adjacent spillbay (#18). The two main entrance weirs were typically operated between 2 ft and 12 ft of submergence to provide sufficient head drop to produce about 4 ft/s across the openings and 2 ft/s channel velocity. Total ladder discharges would vary from 630 cubic ft per second (cfs) at tailwater elevation 10 ft to 2250 cfs at tailwater elevations above +34 ft NGVD 29).

Fixed ladder Weirs 18 through 53 (the weir number also corresponds to the crest elevation) were constructed as restricted overflow weirs while full width overflow weirs were used in the lower end of the ladder (Weirs 8 through 17). All weirs contained two orifices; both located in the same end of the weir, and alternated to provide a staggered pattern. The restricted overflow weir portion is sized such that the main stem ladder flow is adequate to operate both branches without adding makeup water at the junction pool. The fish ladder was operated over a range of upstream heads on the weirs from 1 ft to 1.3 ft, except at low forebays where capacity is not sufficient to develop a 1 ft of head. Auxiliary water feeds the lower end of the fish ladder through diffusers 14-28 to improve transportation velocities in the downstream portion of the fish ladder when inundated by tailwater.

By 1970, several modifications had been gradually made throughout the fishway to resolve various problems. Most changes were mechanical in nature consisting of replacing wooden components with metal. One of these changes may be significant to fish passage. Specifically, when the large wooden slats over the diffuser pool bottoms (flush with the channel invert) were replaced by metal grating that rest over the individual diffuser openings 2 ft below the channel invert. This in effect creates deeper pools (diffuser pools) throughout the ladder with inverts 2 ft lower than the adjacent floor.

The largest system changes were ushered in with the Modifications for Peaking (power) study in 1973. This study was conducted to improve the Bonneville Project's capability to control upstream peaking discharges. The following structural and operational modifications were made as a result of this study:

- The fixed weirs crest lengths were reduced with spacers. The main weir opening was reduced from 15 ft to 8 ft and the side weir from 13 ft to 4.25 ft.
- Operational limits to Forebay were changed from 70-82.5 ft NGVD29 to 70 –77 ft NGVD29.
- AWS fish valves (FV4-3 and FV4-4) were automated.

- Operational limit of 5 pounds per square inch (psi) pressure difference between AWS conduit and open channel was established in agreement with fisheries agencies.
- One new orifice cut into each ladder weir and permanent closure of one of the existing pair, maintaining the number of operating orifices as two. The orifice pattern switched from alternating to symmetrical: an open orifice on each side of ladder.
- Removed the wooden stop logs on the ladder Weirs (8-53). These were replaced with concrete stop slogs of the same dimension.
- Removed the wooden baffles in all diffusers and replaced with single concrete baffles in the ladder diffusers (the entrance channel diffusers were left without baffles).

The most recent changes to the ladder system were made during the 2002 and 2003 winter maintenance period. During the 2002 maintenance period, 8.5-inch radius half-rounded pipe sections were added to the edges of the main fixed entrance weir for lamprey passage. This effectively reduced the weir opening width from 8 ft to 7 ft-3.5 inches. During the 2003 maintenance period, the side spillway entrance was closed. Though these modifications were not of the same magnitude as past modifications, it does have a significant impact on the fishway entrance conditions and accuracy of the numerical model.

2.2 Existing Fishway

The B Branch fishway is located on the north side of Bradford Island and continues along to the south end of the spillway. The ladder is approximately 1,225 ft long (from spillway entrance to Weir 82) and ranges from 30 ft to 40 ft wide. The slope is 1 vertical on 16 horizontal. The A and B Branch Fishways share a common exit section, meeting at a junction pool (see Plate 1). The common exit is approximately 480 ft long and 40 ft wide. The shared portion of the two branches of the Bradford Island Fishway (the junction pool to the fishway exit) is evaluated in the HELCRABS Bradford Island A Branch Evaluation Report (release pending) and therefore is not further evaluated as part of this report.

2.2.1 Ladder Entrances

Fish access to the ladder is through the fishway entrance located next to Spillbay 18. Between the last pier and the entrance openings, the entrance is divided into two separate and adjacent bays. The north entrance has two fixed weirs and the south entrance has two sluice gates. Entrance locations are illustrated in Plate 2. Detailed drawings of the entrances are provided in Plate 3.

2.2.1.1 Fixed Weirs (north side entrance)

Two fixed weirs are located in the north side of the entrance. The southern weir is the main weir and discharges parallel to the spillway flow and northern weir discharges perpendicular to the spillway flow into the adjacent Spillbay 18.

2.2.1.1.1 Main Fixed Weir (SO-SG-2)

This weir is always open when the ladder is operating. The fixed weir consists of a 39.3 ft high by 15-ft wide metal bulkhead assembly with the inset weir opening. The weir bulkhead is seated within the 15-ft wide concrete south entrance channel and on the floor invert at 2 ft above sea level. The weir crest is fixed at elevation 6 ft, 4 ft above the invert on the upstream side. There are three crossbeams across the opening spaced about 13 ft vertically apart. Each crossbeam consists of two 6-inch angle irons butted together.

The width of the opening was measured at 7 ft-3.5 inches. It was originally 10 ft. A 2 ft spacer was added in the 1970's to reduce the width to 8 ft. The width was reduced further in the previous in-water work season with the addition of rounded sections to sides of the opening. Steel 8.5-inch diameter half-rounds were welded to the sides of the slot to aid lamprey passing the entrance.

2.2.1.1.2 Side Fixed Weir (SO-SG-7)

The side weir is adjacent to the main fixed weir, opening north to the spillway. The side weir was operated through the 2002 season, but has now been closed off permanently with a bulkhead. The weir discharged to Spillbay 18, but is being closed since the heavy flow in the adjacent spillbay causes backflow and sloshing in the fishway. This weir would have been closed earlier, like the one at Cascades Island, except there was only one bulkhead between the two systems. The weir has the same crest elevation as the main fixed weir (6 ft). The addition of a spacer identical to that installed in the main fixed weir altered the actual crest length of the weir to 4.25 ft. The same modifications for lamprey passages were also added further reducing the width of the weir opening to 3 ft-6.5 inches. This weir has the same type of crossbeams as described for the main weir.

2.2.1.2 Sluice Gates (south side entrance)

There are two sluice gates on the south side of the entrance system. Like the main fixed weir, the sluice gate assembly is mounted on a removable bulkhead set in the 15 ft wide entrance channel. The bulkhead dimensions are 40 ft high and 15 ft wide. The two sluice gate openings are 10 ft high and 6 ft wide when fully opened. The elevations of the bottom crest of the gate openings are 3 ft, 1 ft above the invert floor.

2.2.1.2.1 SW-SG-4N and 4S

The sluice gates are operated open/closed. The number of open gates is a function of the tailrace level. As presently operated, both gates will be closed at medium to high tailrace levels (greater than 17 ft) and both are open at very low tailrace levels (less than 9 ft). The north gate (4N) is opened first.

2.2.2 Auxiliary Water Conduits

An AWS is used to furnish most of the attraction flow for the entrance openings and augments flow in the collection channel and lower submerged ladder section. The AWS flow is supplied through conduits from the forebay and is released through diffusion chambers located under the floors of the collection channel and certain lower ladder pools. The AWS is composed of two separate conduits: the south delivers to the ladder section, and the north supplies the collection channel and fish lock channel. The forebay intakes for the AWS are located on the north side of Bradford Island adjacent to the spillway (see Plate 2). Large spaced trash racks protect the six intake openings. From there, the flow is channeled to the equalization chamber where the AWS fish valves are located. Fish valves FV4-3 and FV4-4 control the rates of AWS flow into the south and north conduits respectively.

2.2.2.1 Fish Valve 4-3 and the south conduit

The south AWS conduit supplies the 11 diffusers (FG3-18 through FG3-28) in the ladder system. The conduit starts at the control valve FV4-3 at the equalization chamber and ultimately runs adjacent to the ladder on the south side from Weir 8 to Weir 45. Between the fish valve and the first diffuser (FG3-28), the conduit undergoes three vertical bends. The conduit invert starts at elevation 4 ft at the valve, drops abruptly to -11 ft NGVD29 and rises back up to +20 ft NGVD29, elevated 12 ft above Weir 8. The conduit is 8 ft square at Weir 8 and ultimately tapers to 4 ft square at the downstream end at Weir 45. At each diffuser, there are drop shafts from the conduit to the diffuser orifice and gate opening. At Weir 8, the drop shaft plunges nearly 25 ft. Since the conduit is sloped less adversely than the ladder, the drop shaft is less than 10 ft at Weir 45. Baffles were added to the ladder diffusers that are not included in the entrance diffusers. Refer to Plate 4 for general diffuser layout.

Diffusers FG3-14 through FG3-17 have been permanently closed. Thus, diffuser FG3-18 at Weir 31 is the upper most diffuser in the B Branch ladder. The dimensions for the orifices are 3 ft square.

2.2.2.2 Fish Valve 4-4 and the north conduit

Fish Valve 4-4 (FV4-4) feeds the north AWS conduit that supplies the 5 diffusers (FG3-29 through FG3-33) in the collection channel and fish lock channel. The conduit runs entirely within the large wing wall for Spillbay 18. The conduit starts at the control valve FV4-4 at the equalization chamber, drops into a 180-degree vertical bend, and runs adjacent to the collection channel on the south side.

2.2.3 Overflow Ladder Weirs

The width of weir channel is 30 ft between Weirs 8 and 18, transitions to 40 ft at Weirs 18 through 20, and remains at 40 ft for Weirs 20 through 53 just down stream of the junction pool. The weirs are notched at two sides with approximately 10.4 ft of overflow crest. Each weir is comprised of the following multiple parts:

- The 4 ft high permanent concrete weir that spans the width of the channel;
- The two sets of 2 ft high beveled concrete stop-logs that rest atop the permanent weirs: a lower row of stop logs and a second row of stop-logs atop the lower row. The total length of the upper row is 10.4 ft less than the lower row, creating a notched weir with 10.4 ft of overflow crest and the remaining non-overflow section with a crest set 2 ft higher.
- Three vertical metal support irons that hold the stop-log weirs in place: two on the upstream side, one on the downstream side.

There are a total of two orifice openings in each weir. The orifice openings are 2 ft square and are symmetrically oriented near each side of the channel.

Section 3: Numerical Model

NHC developed the Bonneville B Branch numerical model under the HELCRABS program in 1998. The model for the B Branch Fishway produces a simulation of the hydraulic conditions within the lower and middle portions of the ladder system. The results are used to evaluate the fishway performance with respect to fisheries criteria and develop operational plans for a full range of project conditions (tailrace and forebay levels). The program simulates conditions at the entrances, collection channel and diffusers and overflow ladder system up to the picketed lead, where the upstream ladder head is controlled by the forebay exit and head control system (the forebay exit and ladder head control systems are not included in the simulations). The program requires the following input parameters from the user:

- Forebay level
- Tailrace level
- Open entrances (weirs and sluice gates), operated as opened or closed
- Open diffusers, operated as opened or closed
- Fish valve settings
- Head above overflow weir crest at upstream end of fish ladder section.

The program then produces the following output information:

- Entrance head and flow rates from each entrance opening
- Channel velocities and water levels in the collection channel
- Diffuser discharge rates and velocities
- Head, flow rates and velocities across overflow ladder weirs and orifices
- The output from the pressurized system can be obtained from a separate output text file. This includes flow rates, velocities, and hydraulic grade line throughout the AWS conduits and diffuser branches.

3.1 Model Operation

The B Branch model is run in a DOS command prompt by entering the following in the command line:

BONNB [INPUT] [OUTPUT]

The [INPUT] file name has to be consistent for the two required input files the [INPUT].in and the [INPUT].inp file. The [OUTPUT] file can be any name except FISH, which is an intermediate file name generated by the program. Once the BONNB command and file names are entered, the program is executed and an input screen appears that allows for changing diffuser, tainter valve, entrance settings, and other values relevant to the model operations.

Once the desired settings are set in the input screen, the program is set to iterate to find a solution. The program operates two main subprograms to produce a final solution. Subprograms 'FISHBONN' and 'KPIPE'² are alternately run to iterate towards a convergence in flow rates between open channel and closed conduit systems. FISHBONN simulates the open channel portion of the system including ladders, collection channel and entrances. KPIPE operates the closed conduit portion of the system (the AWS), including fish valves, conduits, gates and diffusers. At completion, FISHBONN provides water levels at each diffuser to KPIPE. Conversely, KPIPE runs to return diffuser discharge rates to FISHBONN. This iterative procedure continues until the differences in flow rates between the two program routines are brought within the user specified tolerances.

There are three geometry files that are read by the program to conduct the simulation. A user knowledgeable of the program can modify these files (without actually modifying the model code) and change the results of the computer simulations:

- INP file - file created from the Graphical Users Interface (GUI) interface by the user; user inputs forebay & tailrace levels, open entrances, and fish valve settings.
- FDR file - file contains unchanging geometry information and pertinent head loss coefficients for the open channel portions of the system and the fish valves including the entrances, collection channel, ladder weirs, and fish valves.
- IN file - file contains unchanging geometry information and head loss coefficients (friction and minor loss) for the pressurized AWS systems including the conduits, diffuser gates, and diffusers. This is also the location the GUI imports diffuser gate status, either open or closed.

After a successful simulation, the open channel results are written to [OUTPUT].prn, and the closed conduit portion results are written to [OUTPUT].txt. Both output files can be viewed in any text editor or printed. The files [OUTPUT].in and [OUTPUT].inp are also generated so that the model run can be repeated without having to spend time reentering information into the input screen of the program.

3.2 Numerical Model Evaluation

EC-HD evaluated the model by comparing the model outputs to analytical expectations. Through use of the model and a more detailed review of the model functions as part of this study, the following significant concerns have been identified:

- The program does not operate on computers with NT or WIN2000 operating systems.

² KPIPE is the executable command for Kentucky Pipes, a third party pipe network model.

- Only head data (not flow measurements) was collected in the field to calibrate the original model.
- Entrance weir equation format is limited and prevents the application of the best theoretical equations
- Entrance channel diffusers 31 and 33 cannot be opened individually
- The model uses a sub-program called KPIPE to simulate the hydraulics in the AWS conduits. This program works on the assumption that all conduits are circular and all flow is pressurized. The first of these assumptions is incorrect. The AWS conduits are rectangular. However, we have been able to address this difference through complex adjustments to the geometry files for the model.

More discussion of the models operation is provided in Appendix A of this report.

3.3 Evaluation Procedures

The evaluation process took a two-pronged strategy. The first phase was the collection of field data (including flow rates) that could be used to test the validity of the model over a range of tailwater and valve settings. The second phase was an examination of the program code and the geometry files. The results of both were used to revise the model for more accurate simulations of prototype hydraulic conditions. The following two subsections describe each process.

3.3.1 Field Measurements

Two data collection trips were conducted to provide data sets for model validation. The data collection trips were conducted on 7 Nov 2002 and 2 Jul 2003. These trips included flow measurements at the AWS intake bulkhead slots, the entrance approach channel, the main entrance weir, and the entrance sluice gates. It is preferable to measure all entrances and exits in order to check continuity of flow, but in this case, the ladder flow was neglected since theoretical values showed good agreement with ladder flows measured during A Branch data collection [5,6].

In addition to the flow measurements, the ladder settings (i.e., entrance sluice gate, diffuser, and tainter valve settings) and the water surface measurements were recorded for comparison to model output (project forebay was provided from the control room as well as directly measured from the AWS intake deck). The local tailwater elevation and the powerhouse channel water surface level were taken from the South Spillway abutment deck. The forebay, tailwater, and other water level measurements are accurate to the nearest 0.1 ft. Trip reports for each trip provide more detail of the data collection trips, the data limitations, collection conditions, the data collection worksheets, and a figure providing the locations where data was collected. The trip reports are located in Appendix B.

With field measurements, a certain amount of error will inevitably occur. The introduced error, in this case, is largely a function of the measurement tool being used and the location where the data is being collected.

The Price Meter measures uniform unidirectional flow by counting the revolutions of propeller cups placed into the flow. The rotation count is then converted to a velocity required to move the propeller at that speed. With fewer rotations, as occurs in areas of slower velocities, come lower count numbers and therefore greater percent error. Also, since the Price Meter orients in the direction of flow, it does not provide a vector but a velocity magnitude. Therefore, in areas where flow is not approaching perpendicular to the plane of data collection, the Price Meter would tend to overestimate the flow. As a result of both of these limitations, the Price Meter introduces the most error (approximately 10% to 15%) when used at the AWS intake (flow is slow and less likely to be unidirectional). At a location where flow is pretty much unidirectional and velocities are higher, such as the entrance approach channel, the Price Meter measurements are expected to be within 5% of actual flows.

The second piece of equipment used was an Acoustic Doppler Velocimeter (ADV) mounted on a rigid pole. Used in this manner the ADV provides velocity direction and magnitude and therefore does not have the two weaknesses described for the Price Meter above. ADV measurements are expected to be within approximately 5% of the actual flows at all locations.

For 7 Nov 2002 data collection, the AWS was measured with a Price Meter. Consequently, errors of 10% to 15 % are initially assumed from those locations. For the 2 Jul 2003 data collection, the ADV was used and therefore errors within approximately 5% are expected. In an attempt to further improve accuracy, the directions from the ADV measurements in July were applied to the earlier data set taken with the Price Meter. In doing this, it is expected that the measurement error was reduced to approximately 10% in the November data set at that location. A number of other factors can affect the accuracy of measurements such as channel geometry and sampling locations along a transect or cross-section of flow area. These were minimized by the choice of location of the transects and sampling points within the transect.

3.3.2 Evaluation of Program Code and Geometry Files

The results of a detailed evaluation of program code and geometry files are presented in the EC-HD memorandum: *Bonneville B Branch Fish Ladder HELCRABS Simulation Model*, prepared by B. C. Cook consulting, 18 April 2003. This memo is located in Appendix A of this report.

In general, the following problems (listed in order of significance to the model accuracy) were found in the code and geometry files:

1. AWS flow is underestimated in the current model. This is because the AWS program assumes circular pipes and the B Branch AWS is made of rectangular

- conduits. The diameters provided to the program are based on the rectangular conduits hydraulic radius (important in calculating friction losses) and not the equivalent cross-sectional area of the conduit (important in calculating form losses). In the B Branch AWS form losses are more significant than friction losses and therefore the diameters used in the program should represent equivalent cross-sectional areas. In addition, minor loss coefficients in geometry files for the entrance diffusers of the FV4-3 (north) conduit are too high according to data collected.
2. Current entrance heads are overestimated for a given flow. Equations for the entrance coefficients need to be revised to better-fit theoretical curves and collected data. This includes sluice gate entrance coefficients for weir flow and orifice flow as well as the entrance weir coefficients.
 3. Model does not allow for tailrace exceeding +29.5 ft NGVD29. The hard coded³ maximum tailwater elevation of +29.5 ft NGVD29 needs to be removed so that the program can be used to predict conditions for the entire range of operating tailraces at Bonneville.
 4. The program is not usable on Windows operating systems more recent than Windows 98 making the program incompatible with any computer currently connected to a Corps network.
 5. Output is not easily related to the ladders operating criteria. This is because the output file only provides information on the open channel portion of the system. In addition, it does not reiterate all of the input data. Other input and output modifications would improve the ease of user operation.

Items 1 and 2 have been corrected so that the model is operating adequately to conduct this evaluation. Specifically, the revised B Branch model incorporates revisions to cross sectional areas and minor loss coefficients in the AWS system as well as orifice, weir, and contraction coefficients at the entrances. All changes were made to better-fit theoretical values and measured flow data. The changes to the entrance computational values are provided in Table 3.1. The detailed modifications to the AWS system are provided in Appendix A along with the more detailed discussion of the model.

Item 5 has been partially corrected by modifying the batch file so as to provide the output of the closed conduit calculations in a .txt file. Any further improvement would probably require modification to the program code.

Items 3 and 4 above cannot be corrected without revisions to the program code, which is beyond the scope of this phase of the study. These items impact the utility of the model but don't exclude the models use for the purposes of this study.

³ Hard coded means that the value is written into the program code as a constant (maybe in multiple locations) and therefore could only be changed through editing the code directly and recompiling the entire program.

Table 3.1 Numerical Model Entrance Computation Modifications

Variable name in Input file	CHANGES to File		Purpose of Change
	From	To	
Main Fixed Weir			
Crest Length	8	7.29	Actual crest length after modifications for lamprey passage.
Maximum H_1/p value for use of submerged weir equation (C_d)	2.5	5	Extends the use of theoretical weir coefficient equation to entire range where it is theoretically valid.
Submerged weir equation coefficient (C_d)	0.6	0.8	Provides a better theoretical value of weir coefficients at higher H_1/p values. The substituted values better fit collected data as well.
Submerged weir equation coefficient (C_d)	0.5275	1.055	
Submerged weir equation exponent	1.4	1.5	Submerged weir equation calls for a theoretical exponent of 1.5 for rectangular sharp crested weirs.
Side Weir Slot			
Contraction Coefficient	0	-0.5	Adjusts results to data taken with the side weir open. The negative value accounts for a greater head drop across the side weir due to a locally depressed tailwater from spill.
Crest Length	5	3.54	Actual crest length after modifications for lamprey passage.
Maximum H_1/p value for use of submerged weir equation (C_d)	2.5	5	Extends the use of theoretical weir coefficient equation to entire range where it is theoretically valid.
Submerged weir equation coefficient (C_d)	0.6	0.8	Provides a better theoretical value of weir coefficients at higher H_1/p values. The substituted values better fit collected data as well.
Submerged weir equation coefficient (C_d)	0.5275	1.055	
Submerged weir equation exponent	1.4	1.5	Submerged weir equation calls for a theoretical exponent of 1.5 for rectangular sharp crested weirs.
Sluice Gates			
Contraction Coefficient	0.00	0.17	Accounts for reduction in effective crest length due to flow lines bending to enter the slot.
	0.00	0.05	
Maximum H_1/p value for use of submerged weir equation (C_d)	2.50	5	Extends the use of theoretical weir coefficient equation to entire range where it is theoretically valid.
Submerged weir equation coefficient (C_d)	0.6	0.8	Provides a better theoretical value of weir coefficients at higher H_1/p values. The substituted values better fit collected data as well.
Submerged weir equation coefficient (C_d)	0.53	1.0550	
Submerged weir equation exponent	1.4	1.5	Submerged weir equation calls for a theoretical exponent of 1.5 for rectangular sharp crested weirs.
Full Gate Opening (G_h)	10.0	12.5	Accounts for underestimation of flow (25%) when the sluice gate becomes submerged. Underestimation due to inappropriate "hardwired" coefficients.

3.3.3 Comparison with Field Measurements

The model simulations were run with the same boundary conditions (tailrace & forebay levels) and operational settings recorded during the collection of the field data. The detailed comparisons between the field measurement and model, original and revised, are described in Appendix A. Summaries of the comparisons are provided in Tables 3.2 and 3.3.

As stated earlier, the expected error from field measurements can be looked at, at a minimum, as a function of the flows being measured. Because of this, the model was considered accurate as long as the model results were within the sampling error of the particular flow location (i.e., 5% for the entrances and 10% for the AWS intakes).

Table 3.2 shows the comparison with the measurements prior to correcting or adjusting dimensions and coefficients in the geometry files (with exception to the vertical slot opening, which changed from 8 ft to 7ft-3.5 inches since the model was developed). The following differences between reliable measurements and the model outputs were noted:

- The entrance heads are comparable on average but are highly variable in direct comparison. The model overestimates the entrance head by about 20% at a maximum.
- The model underestimates the ladder flow by approximately 25%.
- The model underestimates AWS flow rates at equivalent head.

Inferences from these results:

- The ladder weir and orifice coefficients need to be increased.
- The entrance weir (and possibly gate) coefficients need to be revised.
- To better simulate flows and pressures in the AWS system, the conduit/diffuser loss coefficients need to be increased.

Table 3.3 shows the comparison between the measurements and the revised model after correcting or adjusting dimensions and coefficients in the geometry files. The results are improved with the following observations:

- The entrance heads are within 10% for all tests.
- Discharge rates for ladder (weir and orifice) are within 10% of the field data sets.
- Total combined entrance discharge rates are within 5% of the field data sets.
- AWS flow rates are within 5% of the field data sets.

Table 3.2 Summary Comparison of Original model with Field Data

Average Project Conditions (ft)			
	Test Date	11/7/02	7/2/03
Forebay Elevation (ft)		73.9	75.3
Tailrace Elevation (ft)		11.5	13.2
Ladder Head Weir (ft)		1.0	1.2
B Branch Ladder Flow (cfs)			
	Test Date	11/7/02	7/2/03
Measured Discharge (cfs)		106 ¹	122 ¹
Modeled Discharge (cfs)		96	119
	Percent Difference	-9%	-2%
	Average Percent Difference	-6%	
Entrance Discharge Comparison			
	Test Date	11/7/02	7/2/03
Measured Discharge (cfs)		1067	982
Modeled Discharge (cfs)		832	703
	Percent Difference	-22%	-28%
	Average Percent Difference	-25%	
Entrance Head			
	Test Date	11/7/02	7/2/03
Measured Entrance Head Difference (ft)		1.6	1.6
Modeled Entrance Head Difference (ft)		2.0	1.4
	Percent Difference	19%	-13%
	Average Percent Difference	3%	

NOTES:

1. Measured values for B Branch ladder flow are estimates based on measurements taken during the A Branch model verification.
2. Note comparison made with corrected 7 ft-3.5 inch fixed weir crest length in model

3.4 Model Evaluation Conclusions

There were several deficiencies discovered in both the geometry files and the program code. The general items of concern are listed in Section 3.3.2.

The geometry files have been corrected or adjusted so that the program will provide reasonably accurate simulations. With this, EC-HD can proceed with an effective evaluation of the system performance with respect to adult fish criteria. The program code was written with some flexibility by making geometry files available for user access, and as such, the most important changes could be made through the geometry files. See Appendix A for further recommendations for program code changes. However, there remain minor deficiencies in the program code that, when corrected, will provide clearer output and greater simulation accuracy.

Table 3.3 Summary Comparison of Revised Model with Field Data

Average Project Conditions (ft)			
Test Date		11/7/02	7/2/03
Forebay Elevation (ft)		73.9	75.3
Tailrace Elevation (ft)		11.5	13.2
Ladder Head Weir (ft)		1.0	1.2
B Branch Ladder Flow (cfs)			
Test Date		11/7/02	7/2/03
Measured Discharge (cfs)		106 ¹	122 ¹
Modeled Discharge (cfs)		96	119
Percent Difference		-9%	-2%
Average Percent Difference		-6%	
Entrance Discharge Comparison			
Test Date		11/7/02	7/2/03
Measured Discharge (cfs)		1067	982
Modeled Discharge (cfs)		1016	943
Percent Difference		-5%	-4%
Average Percent Difference		-4%	
Entrance Head			
Test Date		11/7/02	7/2/03
Measured Entrance Head Difference (ft)		1.6	1.6
Modeled Entrance Head Difference (ft)		1.5	1.5
Percent Difference		-9%	-9%
Average Percent Difference		-9%	

NOTES:

1. Measured values for B Branch ladder flow are estimates based on measurements taken during the A Branch model verification.

Section 4: Fishway Evaluation

After calibrating and making minor modifications to the numerical model as described in Section 3, the model was used to conduct an evaluation of the Bradford Island B Branch Fishway. The purpose of the evaluation is to determine whether current operational procedures are adequate to meet fish passage requirements throughout the ladder (excluding the control section portion which is not included in the Bradford Island Model). Where model simulations showed the current operating scheme failed to meet hydraulic criteria, an alternate operating scheme was developed using the modified model. The following section describes the operational criteria used to evaluate the ladder, an evaluation of the ladder as it is currently operated, and an explanation of an alternate operating plan developed to improve performance of the ladder with respect to the operational criteria.

4.1 Operational Criteria

The FPP lays out a number of hydraulic criteria agreed by regional agencies to be beneficial to the passage of fish through the projects. These criteria, though still being researched, are used in this evaluation. The primary hydraulic characteristics desired in the ladder are as follow:

- Head drop across ladder entrance – 1.0 ft to 2.0 ft with 1.5 ft optimum
- Minimum entrance weir submergence – 8 ft
- Head over overflow ladder weirs – 1.0 ft (1.3 ft during Shad passage season)
- Channel velocities – 1.5 to 4 ft/s with 2ft/s optimum
- Diffuser velocities – less than 0.5 ft/s

In addition to the criteria listed above, it is noted in Bonneville Dam Design Memorandum (DM) No.1: Modification for Peaking [4] that the AWS system is to be operated to allow no more than 5 psi of pressure differential across the system. The purpose of this operational limitation is that, with no more than 5 psi of pressure differential anywhere in the system, juvenile migrants inadvertently entering the system from the forebay can pass through the trash racks, conduits, and diffusion gratings without sustaining significant injury. The current operations specify the AWS pressure differentials be maintained between 4 and 6 psi. It is assumed in this evaluation that the 4 to 6 psi is consistent with the 5 psi plus a tolerance of ± 1 psi. Therefore the, 4 to 6 psi criterion is applied to this fishway evaluation in addition to the above bulleted items.

The current operational plan for the fishway is provided in the form of a figure listing diffuser valve openings for a given tailwater elevation for all of the ladders at Bonneville (BDF-9-6-OAO/1). Fishway operations are also provided in the FPP for the Columbia River [10]. Plate 5 of this report provides a summary of the diffuser, entrance weir, and entrance sluice gate settings for ladder operations consistent with both the Fishway Operation diagram and the FPP. The operational plan was changed in 2003 with the

permanent closure of the side entrance weir that opens to the spillway side. In previous fish passage seasons up through 2002, the side weir was open. The purpose for the closure is because, under the current spill conditions, surging and backflow through the side gate occurs creating undesirable conditions in the entrance channel. The operational change was coordinated regionally because flow from the adjacent spillbay tends to flow into the ladder and potentially misguide the adults out toward the spillway instead of up the ladder. Since the adjacent spillway bay is continuously operated to provide attraction flow for the ladder, the side entrance is to be kept closed permanently.

4.2 Evaluation Procedures

In order to evaluate the current fishway, the model was used to simulate hydraulic conditions for a single forebay and multiple tailrace elevations. The numerical model was first used to evaluate the current operations by checking the resultant hydraulic conditions from those operations. Specifically model runs were conducted at a forebay of +74.5 ft NGVD29 and seven different tailwater elevations. The model was run without the side entrance gate open for each case to illustrate the conditions generated by the current operations. These hydraulic conditions in the ladder were compared to the operational criteria described above (see Table 4.1). Conclusions from this evaluation are provided in Section 4.3.1.

The evaluation then focused on operating the Bradford Island B Branch Fishway to optimize performance with respect to the operational criteria. This portion of the evaluation consisted of model simulations for tailwater elevations ranging from +7 ft NGVD29 to +29 ft NGVD29 and a constant forebay elevation of +74.5 ft NGVD29. The upper limit of +29 ft is a result of the hard coded maximum for the current B Branch model. Though no model runs were conducted above this elevation, the ladders behavior can be extrapolated beyond this point based on the model runs that were completed and results from the very similar Cascades Island Ladder (which didn't have the same limit).

4.3 Fishway Evaluation Conclusions

4.3.1 Current Operations Plan

According to model simulations, the current Bradford Island B Branch Fishway operations fail to meet the minimum 1.5 ft/s channel velocity in the portion of the channel stretching from the fish entrance to the first unsubmerged overflow weir (the entrance channel). The primary reason for this is because the current operations fail to provide enough flow through the system to generate the minimum velocity in the entrance (or collection) channel.

Table 4.1: Bradford Island B Branch Fishway Numerical Model Results for Current Operations Plan (Forebay +74.5 ft NGVD29)

Tailwater Elevation (ft)	7	10	15	18	21	25	29
SETTINGS							
Inflow: (valve openings)							
Ladder AWS (FV4-3 opening) (ft)	0.4	0.9	2.4	2.3	2.9	5.5	7.0
Entrance AWS (FV4-4 opening) (ft)	1.0	0.6	1.4	0.0	0.0	0.5	1.0
Weir 67 Ladder Head (ft)	1.0	1.0	1.3	1.3	1.3	1.3	1.3
Outflow: (weir elevations, ft)							
South Sluice Gate (S0-SN-4S)	3.0	closed	closed	closed	closed	closed	closed
North Sluice Gate (S0-SN-4N)	3.0	3.0	3.0	closed	closed	closed	closed
Main Fixed Weir (S0-SG-2)	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Side Fixed Weir (S0-SG-7)	closed	closed	closed	closed	closed	closed	closed
DISCHARGE:							
Inflow: (cfs)							
Ladder AWS (FV4-3)	144	294	633	624	886	1114	1302
Entrance AWS (FV4-4)	342	220	408	0	0	165	294
Weir 53 Ladder Flow	96	96	132	132	132	132	132
Outflow: (cfs)							
South Sluice Gate (S0-SN-4S)	263	0	0	0	0	0	0
North Sluice Gate (S0-SN-4N)	230	360	577	0	0	0	0
Main Fixed Weir (S0-SG-2)	88	250	595	756	1018	1411	1728
Side Fixed Weir (S0-SG-7)	0	0	0	0	0	0	0
Total System Discharge (cfs)	581	610	1172	756	1018	1411	1728
FISH PASSAGE & OPERATIONAL CRITERIA:							
Tailrace (ft)	7	10	15	18	21	25	29
Entrance Head (ft)	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Sluice Gate Entr. Submergence (ft)	4.0	7.0	12.0	closed	closed	closed	closed
Fixed Weir Entr. Submergence (ft)	1.0	4.0	9.0	12.0	15.0	19.0	23.0
Entrance Channel Velocities (ft/s)	1.1	1.2	1.5	1.2	1.4	1.5	1.4
Max AWS Diffuser Velocities (ft/s)	0.6	0.5	0.7	0.4	0.5	0.5	0.5
Δ North AWS (psi) @ FG3-28	3.8	1.6	5.4	0.0	0.0	0.4	0.4
Δ South AWS (psi) @ FG3-30	5.1	4.8	5.4	3.4	3.7	4.8	5.1
RANGE OF LADDER HEADS (ft) (not submerged from tailwater)	Control head = 1.0 ft		Control head = 1.3 ft				
	Weirs 54-67	Weirs 8-53	Weirs 54-67	Weirs 8-53			
Maximum Ladder Head (ft)	1.0	1.1	1.3	1.5			
Minimum Ladder Head (ft)	0.8	1.1	1.1	1.5			

NOTES:

1. Model was run with both Fish Valves (FV4-3 and FV4-4) fully open to show the pressure required across the AWS. At higher forebays the ladders ability to meet entrance head is limited by the system pressure differential (which is in turn limited by the current diffuser schedule).
2. Instance where fishway performance parameters not meeting criteria are shaded.

The current plan closes entrances as the tailwater rises in order to meet the entrance head criteria. Unfortunately, when an entrance is closed, such as SO-SG-4S at tailwater levels greater than +9 ft NGVD29 and SO-SG-4N at tailwater levels greater than +16 ft NGVD29, the total flow through the system is reduced. At the same time the entrance channel depth is increased (with the increasing tailwater). The result is less discharge through a larger flow area and a subsequent reduction in channel velocity. This situation is further exacerbated because the side weir entrance is to be kept closed for all future operations. This introduces a compromise in achieving compliance with the ladder criteria. With the reduced entrance flow capacity (a result of the 2 ft spacers, half rounds, and closure of the side weir), the desired head at the entrance limits the flow through the system and consequently the entrance channel velocities. If the flow were increased to generate the desired velocities, the entrance head would increase to the upper end of the desired head criteria or exceed the head criteria. In the Cascades Island Fishway a third

criteria, that of a maximum of 5 psi pressure differential through the diffusers, needs to be balanced against the others. However, the B Branch diffuser systems are apparently more efficient and are able to provide necessary flow to meet minimum velocity criteria without exceeding pressure criteria. Therefore, only the entrance head and the channel velocities are in conflict in the B Branch system.

4.3.2 Recommended Alternate Diffuser and Entrance Operations

After identifying the limitations of the existing ladder operations (the conflicting constraints placed by the entrance head and the channel velocity), the model was used to find alternative ladder operations to optimize the hydraulic conditions in order to meet criteria as closely as possible. The primary problem with the current system (as discussed above) is that by closing the side entrance it becomes difficult to meet both the channel velocities and stay within the entrance head differential. What is needed from an operational plan to meet the criteria listed in Section 4.1 is the following: 1) that the entrances be opened to allow the minimum ladder discharge at which the entrance channel velocity can be maintained, and; 2) that more flow be provided so that the head differential can be met with the additional entrances open. The latter can easily be done without the AWS system pressure differentials exceeding 5 psi (a problem with the Cascades Island Fishway). This cannot be done with the current diffuser schedule and therefore an alternate operations plan was developed using the numerical model. Key changes to the current operating plan are as follows:

- The sluice gate entrances were kept open longer to better allow for the required flow to meet channel velocity criteria in the entrance channel.
- The ladder diffusers (FG3-18 through FG3-28) were set as the priority diffusers since they contribute flow to the entire entrance channel (the old fish lock diffusers only contribute immediately in front of the entrance). This approach has the additional benefit of inducing extra flow and head in the critical submerged ladder section where fish passage can often be hindered. These diffusers will be turned on as soon as the tailrace reaches the elevation of the upstream weir of the diffuser's pool, i.e., FG3-27 will be turned on for tailwater elevations exceeding +9 ft NGVD29 (the elevation of downstream pool weir) rather than +10.5 ft NGVD29 as called for under the current plan. Also, fish valve FV4-3 was adjusted to operate at 5 psi to maximize flow from the ladder portion of the AWS.
- The entrance diffusers (FG4-29 through FG4-33) were opened and operated to provide additional flow at the entrance when needed to meet the head criteria at the entrance.
- When the optimal 1.5 ft of entrance head can no longer be met by the available diffusers, while maintaining the AWS system pressure differential below 5 psi, the first sluice gate should be shut off (SO-SG-4S). This occurs at tailwater elevations greater than +27 ft NGVD29 in this modeling study. Once the south sluice gate is closed channel velocities can barely be maintained above the minimum criteria of 1.5 ft/s.

- The second sluice gate (SO-SG-3N) can be kept open up to tailwater levels where the entrance head can no longer be maintained above the minimum entrance criteria (1 ft). Once the second sluice gate is closed, the minimum channel velocity can no longer be met.
- The AWS system pressure differential should then be maintained at 5 psi, maximizing flow for the remainder of the tailwater levels. The entrance head will likely drop below optimal criteria at the highest tailwater levels (greater than +34 ft NGVD29).

As stated above, the alternative operation scheme keeps the sluice gates open longer and brings the ladder diffusers on line as soon as their pools are submerged by the tailrace rather than the 2 ft lag between tailwater and diffuser pool elevation called for in the current plan. Activating the ladder diffusers earlier allows for more flow at a given tailrace and has the added benefit of producing greater head differential across the submerged weirs. In addition to bringing the ladder diffuser (FG4-18 through FG4-28) on line at lower tailwater levels, the entrance channel diffusers (FG64-29 through FG4-33) are also used at lower tailraces than in the current plan. Plate 6 provides the recommended diffuser and entrance schedule for a range of tailwater levels as well as the tainter valve settings for a number of forebay elevations. Simulation results using the alternate diffuser and entrance settings are provided in Table 4.2. Note that even when the diffusers are brought on line more aggressively, maintaining the entrance head above 1 ft requires that one sluice gate is closed at a tailwater of +27 ft NGVD29 and the second gate will likely need to be closed at a higher tailwater. After the second sluice gate is closed, the channel velocity criteria are no longer met and likely cannot be met without some sort of structural modification. Potential structural modifications are provided in Section 5.3 below.

**Table 4.2: Bradford Island B Branch Fishway Numerical Model Results for
Recommended Operations at Forebay +74.5 ft NGVD29**

Tailwater (ft)	Performance with Respect to Criteria					Settings			
	Entrance Head (ft)	Δ Ladder AWS (psi)	Δ Entrance AWS (psi)	Maximum Diffuser Velocities (ft/s)	Entrance Channel Velocities (ft/s)	Ladder (south) AWS (FV4-3) (ft)	Entrance (north) AWS (FV4-4) (ft)	Ladder Head (ft)	Total Entrance Flow (cfs)
7	1.5	5.1	3.8	0.5	1.1 ²	0.4	1.0	1.0	580
8	1.5	4.7	3.4	0.5	0.9 ²	0.4	1.5	1.0	730
9	1.5	5.1	3.3	0.5	1.3 ²	0.9	1.5	1.0	870
10	1.5	5.3	3.3	0.5	1.6	1.5	1.5	1.0	1030
11	1.5	5.0	3.5	0.5	1.8	2.0	1.6	1.0	1170
12	1.5	5.3	3.2	0.5	1.8	2.2	2.1	1.0	1340
13	1.5	5.1	4.8	0.7 ²	1.6	2.2	2.8	1.0	1490
14	1.5	5.4	4.7	0.6 ²	1.8	3.0	2.8	1.0	1640
15	1.5	5.2	4.1	0.6 ²	1.8	3.0	3.3	1.3	1810
16	1.5	5.3	2.6	0.5	1.7	3.1	2.5	1.3	1620
17	1.5	4.2	2.2	0.4	1.6	3.2	2.3	1.3	1610
18	1.5	5.1	2.3	0.5	1.7	3.8	2.4	1.3	1720
19	1.5	5.3	2.6	0.5	1.6	4.0	2.6	1.3	1780
20	1.5 ¹	5.2 ¹	2.9 ¹	0.5 ¹	1.6 ¹	4.4 ¹	2.8 ¹	1.3 ¹	1870 ¹
21	1.5	5.1	3.2	0.5	1.6	4.7	3.0	1.3	1960
22	1.5	5.2	4.0	0.6 ²	1.7	4.9	3.5	1.3	2080
23	1.5	5.1	3.7	0.6 ²	1.6	5.6	3.4	1.3	2160
24	1.5	5.1	4.7	0.7 ²	1.7	5.7	4.0	1.3	2280
25	1.5	5.2	5.4	0.7 ²	1.5	5.9	4.4	1.3	2340
26	1.6	5.1	5.2	0.7 ²	1.6	6.6	4.4	1.3	2450
27	1.4	5.1	5.1	0.7 ²	1.5	6.8	4.4	1.3	2450
28	1.5	5.2	2.3	0.5	1.5	7.0	2.7	1.3	2120
29	1.5	5.0	2.1	0.5	1.5	7.8	2.6	1.3	2170

Notes:

1. Values were interpolated at a tailwater of 20 ft because the numerical model would not converge to a solution.
2. Instance where fishway performance parameters not meeting criteria are shaded.
3. The ladder head was set to 1 ft for tailwaters below 15 ft because the lower tailwater elevations are more likely to occur during the months that shad aren't passing and the target head would more likely be 1 ft. The ladder target ladder head is not actually a function of tailwater but the shad passage season.

Section 5: Recommendations

There are a number of recommendations as a result of this model study. Recommendations primarily consist of operational or structural changes to improve performance of the Bradford Island B Branch ladder with respect to operational criteria but some pertain to the numerical model itself. The recommendations for the numerical model and fishway are provided in the following sections.

5.1 Numerical Model Modifications

While the most important corrections have been made to the geometry files, there remain several items that require direct revision to the program code to ensure greater accuracy and provide more useful output information. The following recommendations are earmarked for the future correction of the remaining program deficiencies:

1. In general, the program code should be revised to remove hard coded limitations and improve in transparency of the codes performance.
2. Replace the Kentucky Pipes closed conduit simulator with one that allows for rectangular conduits and also is compatible with the currently required operating systems for the Corps.
3. Provide user options to change output defaults to provide:
 - a. Expanded output to include all input data, including geometry (IN & INI) file, which makes for an complete document upon future review
 - b. Include results from pressurized system (AWS) with main output file (currently a separate file)
4. Output should include magnitude and location of maximum pressure differentials between AWS conduit and adjacent ladder system; and
5. Forebay level should be shown in output.

In addition to addressing the remaining program deficiencies, there are potential enhancements that could empower the user to extract more visually descriptive output information while simultaneously requiring less effort upfront.

Addition of a GUI for the user (such as an excel worksheet) so that graphical as well as tabular output may be provided.

- Graphical output: Output data file can be processed automatically and displayed graphically so that a large number of users with varied backgrounds can understand conditions in the ladder;
Color coded tables that display green when section of the ladder are in criteria and red when out.
Ultimately, the model results could be displayed on a drawing of the ladder system so that when the user selects a location on the fishway (diffuser, entrance opening, channel location, et al.), the flow rates, velocities and water levels would be displayed.

5.2 Fishway Operational Modifications

The current ladder fails to meet operational criteria over the full range of tailwater levels encountered at Bonneville. The primary reason for this is because the reduced flow capacity of the entrances (if the head criteria is to be maintained). In addition, the current diffuser schedule fails to provide enough water to meet the entrance head criteria with the open entrances necessary to meet the channel velocities. EC-HD recommends a trial operation of the ladder entrances and AWS system in accordance with Plate 6 of this report prior to any implementation of the proposed operations. This alternative operational plan requires that the sluice gate entrances be held open through higher tailrace elevations and that the diffusers be brought on line more aggressively to provide the required discharge for the maintained entrances without exceeding the maximum system pressure differential. The use of more diffusers from the south AWS at higher tailwaters does create the potential for the upstream most diffusers to draw water from the ladder rather than supply water to the ladder. This would be a result of increased losses through the AWS system due to the increased flow and the higher elevation of the upstream diffusers. The numerical modeling did not show this occurring but it is something that would need to be monitored during field verification of the proposed diffuser schedule provided in Plate 6. During these trial tests, it is recommended that flow data, similar to that conducted by EC-HD for this study, be collected.

5.3 Fishway Structural Modifications

If the modified operational plan recommended in Section 4.3.2 is implemented, the ladder system will be able to meet the entrance channel velocities, entrance head, and system pressure differential for a majority of tailwater levels encountered at the project at the expense of more flow through the system. If this additional ladder flow is not available, the project could consider modifying the entrances to allow more control of the total system discharge. The recommended operational plan uses the diffusers (FG-4-29 through 4-33) for the old fish lock system more extensively. There may be concern that the use of these diffusers might misguide fish into the old fish lock system. It is recommended that the project investigate structural alternatives to deal with conflicts between these changed operations and current project goals (i.e., minimizing flow through the ladder system). This section briefly outlines a number of hydraulic passage modifications that the project could look into in more detail.

Picket leads at old fish lock system approach:

As stated above, the use of the diffusers in the fish lock approach channel may affect the guidance of fish up the ladder. They may be initially confused as to which stream of water to follow at the junction of the short lock channel and the ladder channel. In order to avoid or minimize confusion, picket leads could be installed across the channel to keep fish out of the fish lock channel and to help guide fish around the collection channel bend and up to the ladder. The fishway operational plan already calls for use of the fish lock

channel diffusers at higher tailwater levels and, therefore more extensive use of these diffusers in the recommended plan may not be an issue.

Entrance modifications:

Even under the modified operational plan provided in Plate 6, the B Branch Fishway fails to meet the 8 ft submergence criteria for tailwater elevations under +9 ft NGVD29 and likely fails to meet the channel velocity criteria at the highest tailwaters. In order to address these deficiencies, it is recommended that the project consider modifications to the entrances to provide more hydraulic control of the system.

Alternative A would be to replace the two sluice gates with a 10 ft wide modulating weir. The modulating weir is a weir that can be raised and lowered with the tailrace providing more control over the entrance discharge. The weir would be maintained with at least 8 ft submergence at all tailraces exceeding 10.3 ft. This will reduce the amount of time the entrance does not meet the submergence criteria from the current 16% to 10% during the fish passage season. In addition, this would provide the required flow to maintain the channel velocities in the entrance channel and better control of the entrance head.

Alternative B would replace the sluice gates and the main fixed weir with two 10 ft modulating weirs with a range from +2.3 ft to +28 ft NGVD29, both operated with 8 ft of submergence over all tailraces greater than +10.3 ft NGVD29. This alternative provides better flow conditions over the lower tailwater ranges, but because the gate maintains 8 ft of submergence, fails to meet the minimum flow requirements at the higher tailwater. This could be improved by creating a slightly more complicated operating scheme in which the weirs submergence is adjusted as a function of required flow rather than tailwater. Alternative B provides an improvement over the current entrance configuration and Alternative A with respect to the minimum submergence criteria of 8 ft since both weirs would have a minimum crest elevation of +2.3 ft NGVD29 instead of the existing +6 ft NGVD29 sill. Due to the likely complexity of operations and expense of installation, Alternative B is likely not a desirable alternative to pursue.

Alternative C would be to replace the fixed weir and sluice gates with a shaped fixed weir. The replacement weir would be wide at the bottom and narrow at the top. The advantage of this type of entrance setup would be greater submergence at all times, less operational complexity, and a potential to have the entrances structured to passively meet both entrance head and channel velocity criteria at the same time. This alternative would need to be extensively modeled before implementation.

Though these alternatives would provide more control at the entrances, there still may be a flow limit through the system as a result of the maximum AWS system pressure differential. To provide the required flow to the entrances, the AWS system pressure differential would need to be raised. More analysis is necessary to determine the feasibility of modifying the Bradford Island B Branch entrances.

Larger Structural Options

There are more massive and costly structural options that might be considered if two separate and opposite priorities were pursued to their logical extent.

1. If conservation of water were placed at a premium, then the option of narrowing the 35 ft wide collection channel and ladder system could be considered. This would reduce the system flow demands according to channel velocity criteria and relieve the stress on the existing AWS system.
A drawback to this alternative is that it reduces the capacity of the fishway. This could be detrimental to efficient fish passage at times of peak salmonid and/or shad migration. As it is now, (at times) the ladder capacity is being completely utilized by passing fish. Reducing capacity could cause overcrowding.
2. The 8 ft minimum entrance submergence criteria for all tailwater levels will probably not change. Thus the option of lowering the invert to the entrance and collection channel should be considered (In lieu of a less likely operational limit on tailrace). Coordination with regional agencies would be necessary for this action. The entrance opening inverts would need to be lowered to at least elevation -1 ft NGVD29. However, this may also require some combination of either a larger AWS system, a narrower ladder system, or a new set of entrance weirs as described in the above alternatives.

A serious recommendation for either of the above options would need to be preceded by an extensive engineering study and an evaluation of cost considerations.

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PLATES

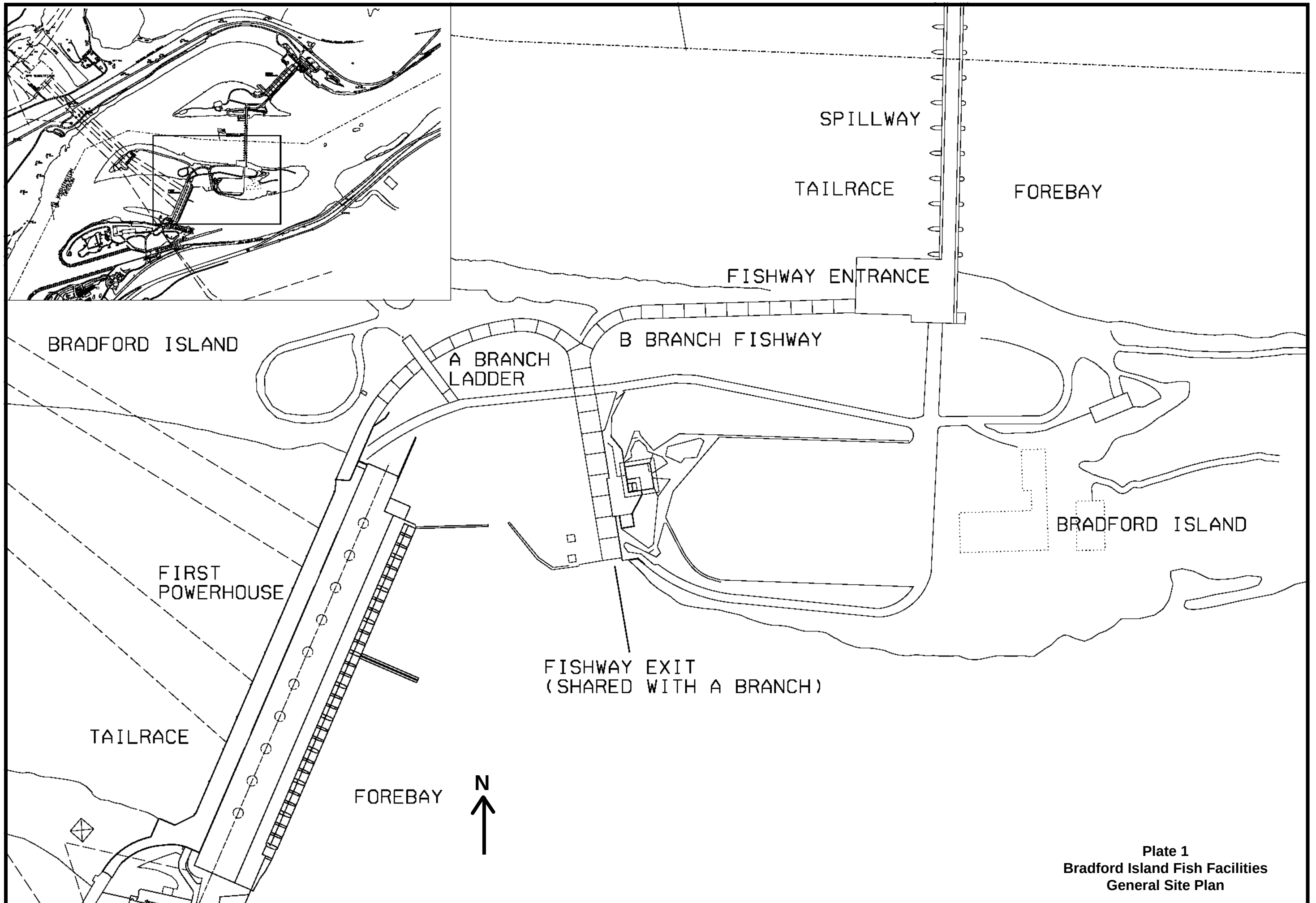


Plate 1
Bradford Island Fish Facilities
General Site Plan

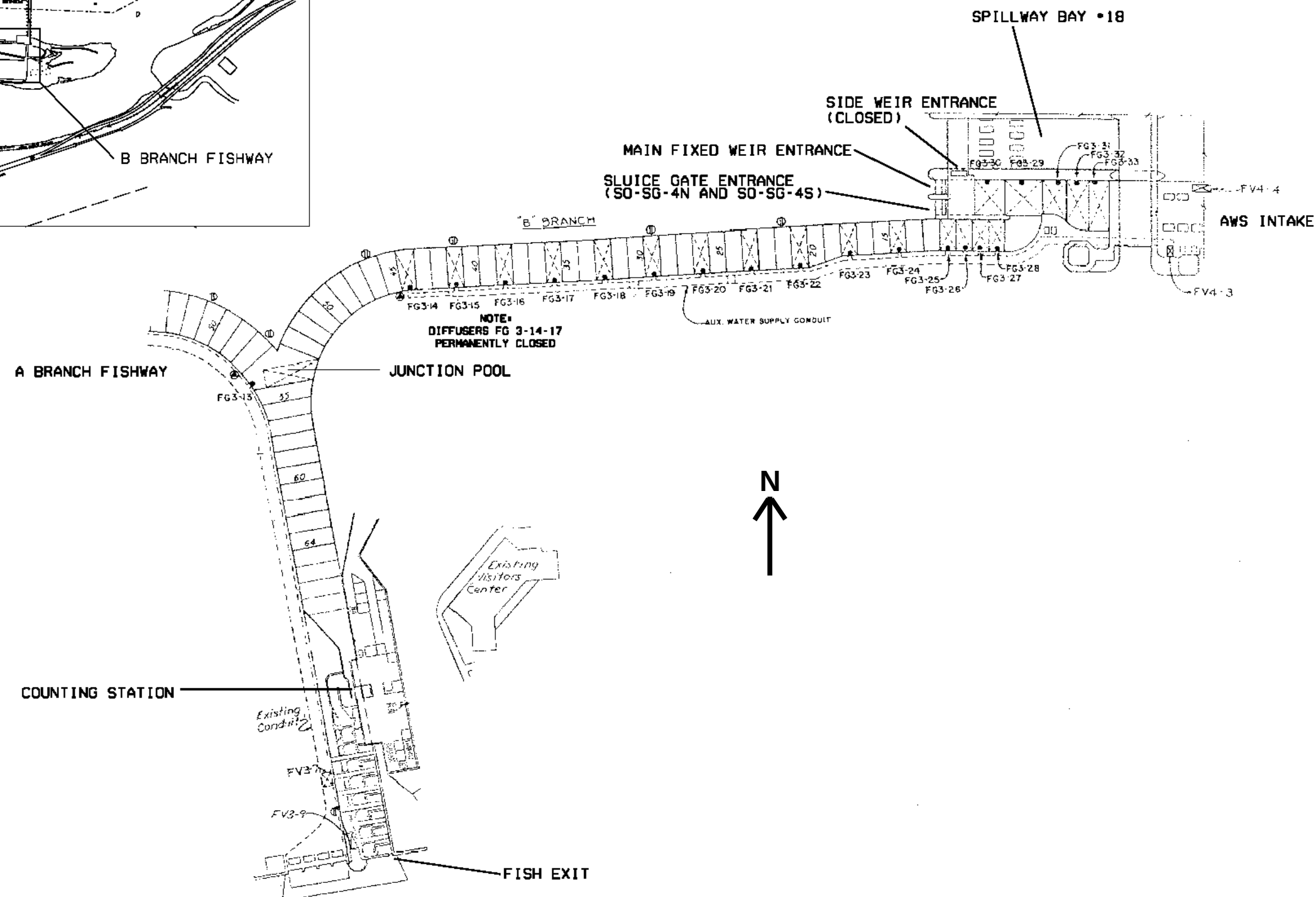
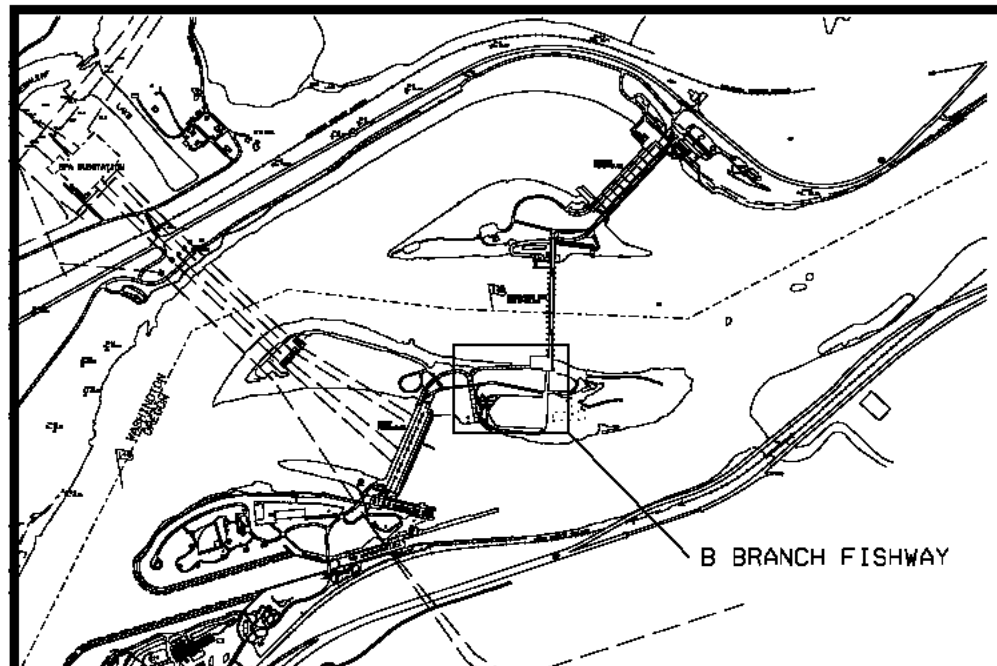
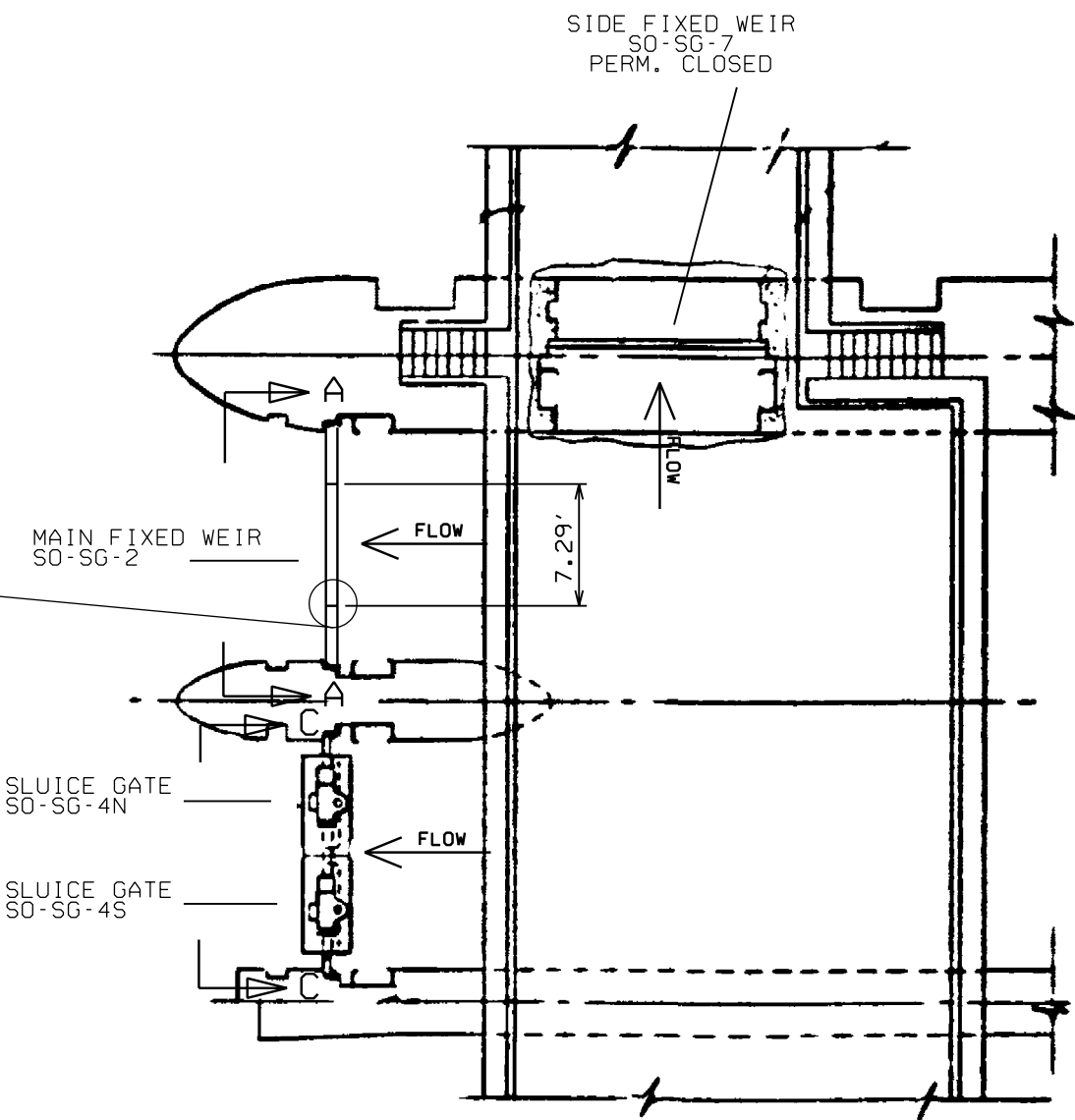
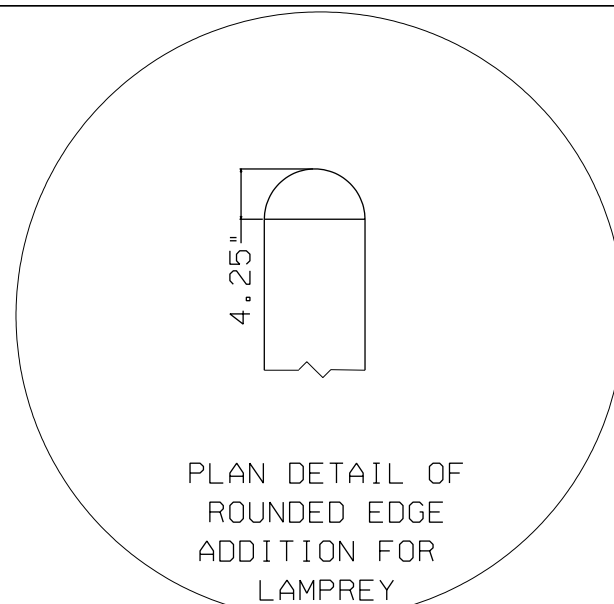
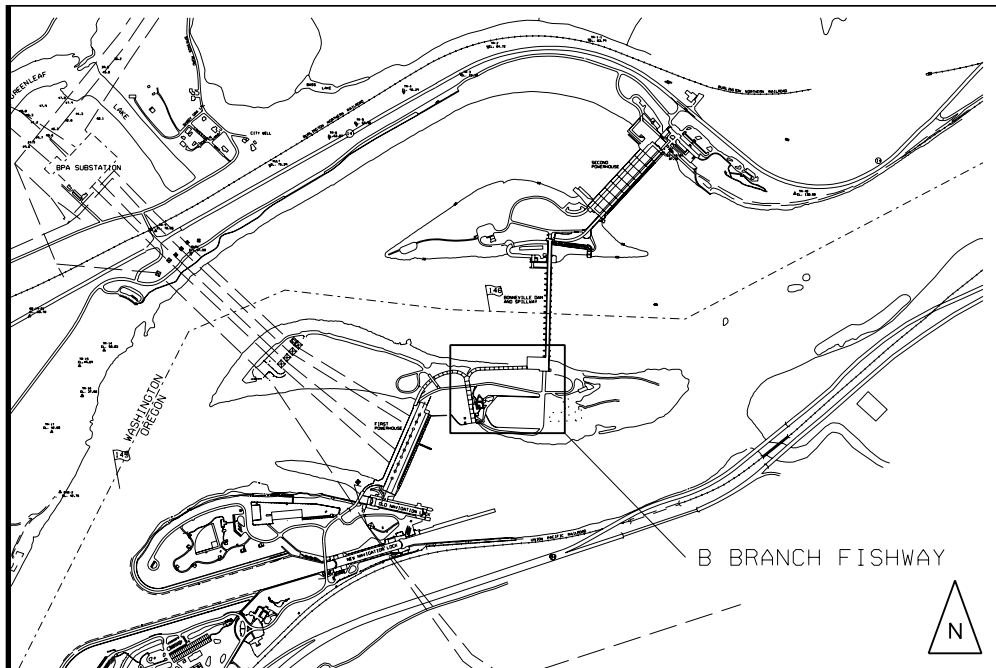
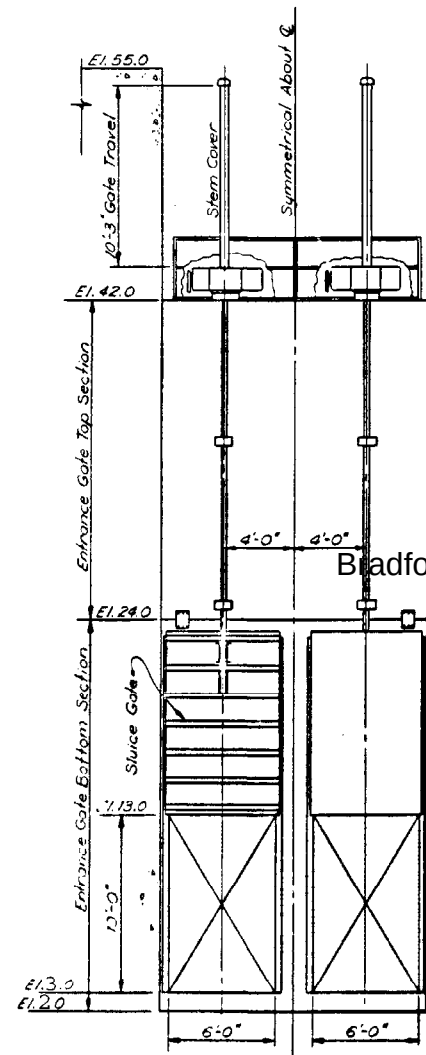
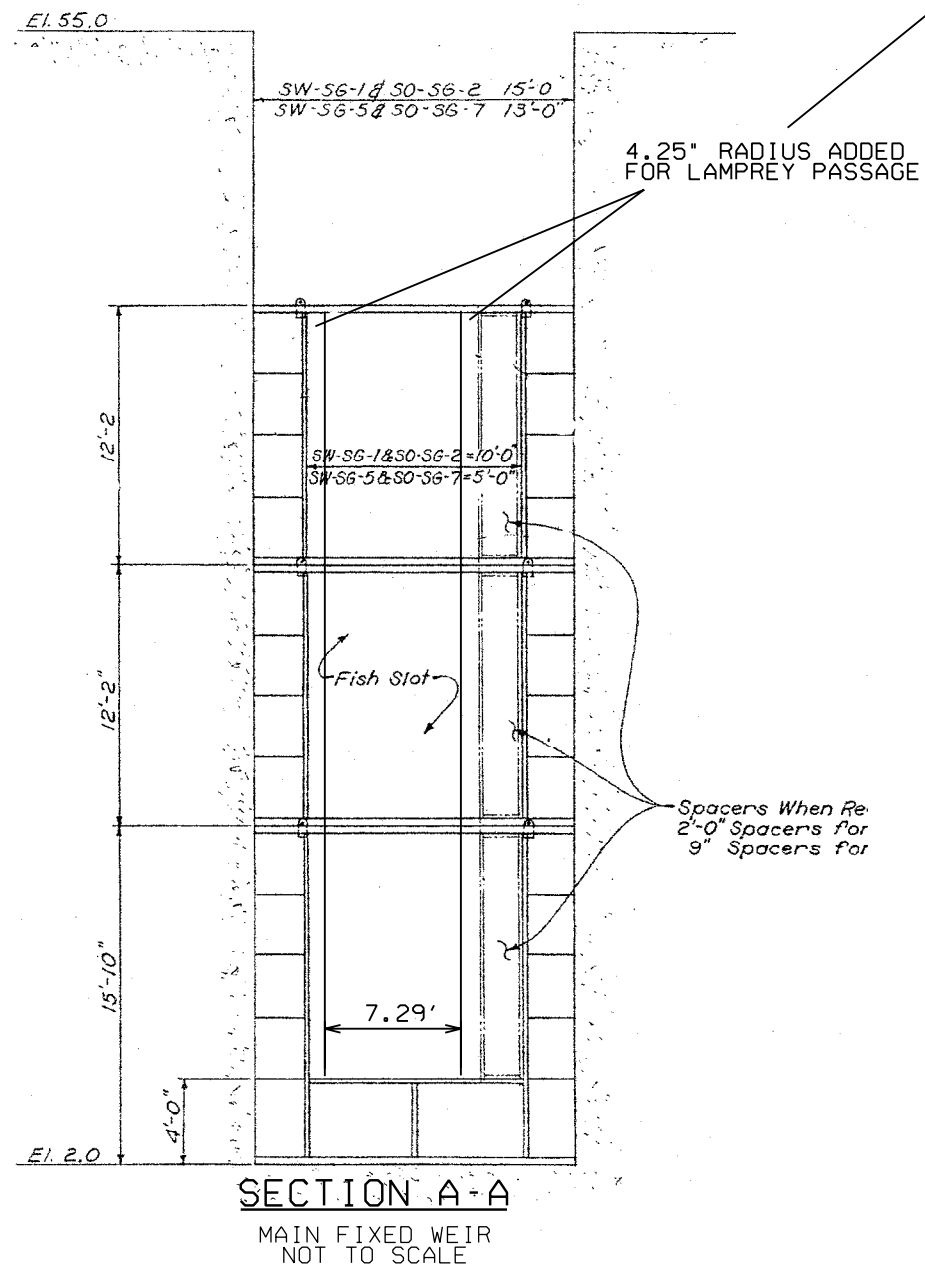


Plate 2
Bradford Island B Branch Ladder
Layout



PLAN VIEW
NOT TO SCALE



SECTION C-C
SLUICE GATES
NOT TO SCALE

Plate 3
Bradford Island B Branch Ladder
Entrance Details

Plate 3
Bradford Island B Branch Ladder
Entrance Details

BONNEVILLE B BRANCH AWS:
 SKETCH OF ENTRANCE TO DIFFUSION CHAMBER
 FROM MEASUREMENTS TAKEN AT DIFFUSER #28
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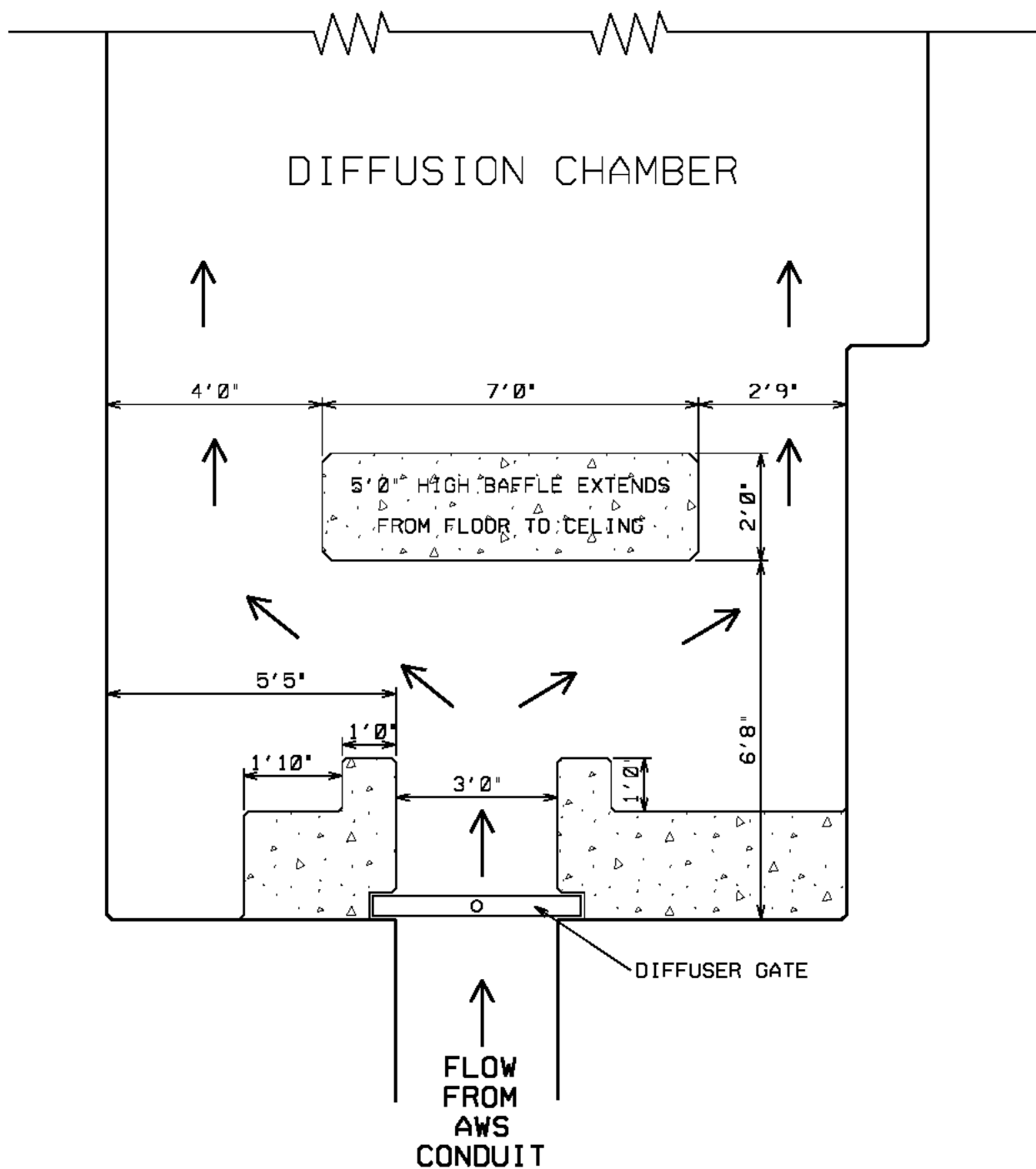


Plate 4
 Bradford Island B Branch
 Typical Fish Ladder Diffuser Layout
 (Below Grating)

Ladder Auxilliary Water Supply Diffuser Schedule

Entrance Auxilliary Water Supply and Gate Schedule

South (Ladder) AWS Diffusers																	North (Entrance) AWS Diffusers					Sluice Gate Entrances		Fixed Weirs	
TW	FG3-14	FG3-15	FG3-16	FG3-17	FG3-18	FG3-19	FG3-20	FG3-21	FG3-22	FG3-23	FG3-24	FG3-25	FG3-26	FG3-27	FG3-28	TW	FG3-30	FG3-29	FG3-31	FG3-32	FG3-33	SG-4S	SG-4N	Main	Side
7	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	OPEN	7	OPEN	OPEN	CLOSED	CLOSED	CLOSED	OPEN	OPEN	OPEN	CLOSED
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NOTES:
1. Current operations call for permanent closure FG3-14, FG3-15, FG3-16, FG3-17, and the fixed side entrance weir. These components are greyed out in the figure.

Ladder Auxilliary Water Supply Diffuser Schedule

Entrance Auxilliary Water Supply and Gate Schedule

South (Ladder) AWS Diffusers																	North (Entrance) AWS Diffusers					Sluice Gate Entrances		Fixed Weirs	
TW	FG3-14	FG3-15	FG3-16	FG3-17	FG3-18	FG3-19	FG3-20	FG3-21	FG3-22	FG3-23	FG3-24	FG3-25	FG3-26	FG3-27	FG3-28	TW	FG3-30	FG3-29	FG3-31	FG3-32	FG3-33	SG-4S	SG-4N	Main	Side
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27	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	27	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	CLOSED
28	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	28	OPEN	OPEN	OPEN	OPEN	OPEN	CLOSED	OPEN	OPEN	CLOSED
29	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	29	OPEN	OPEN	OPEN	OPEN	OPEN	CLOSED	OPEN	OPEN	CLOSED
30	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	30	OPEN	OPEN	OPEN	OPEN	OPEN	CLOSED	OPEN	OPEN	CLOSED
31	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	31	OPEN	OPEN	OPEN	OPEN	OPEN	CLOSED	OPEN	OPEN	CLOSED
32	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	32	OPEN	OPEN	OPEN	OPEN	OPEN	CLOSED	OPEN	OPEN	CLOSED
33	CLOSED	CLOSED	CLOSED	CLOSED	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	33	OPEN	OPEN	OPEN	OPEN	OPEN	CLOSED	OPEN	OPEN	CLOSED
34	CLOSED	CLOSED	CLOSED	CLOSED	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	34	OPEN	OPEN	OPEN	OPEN	OPEN	CLOSED	OPEN	OPEN	CLOSED
35	CLOSED	CLOSED	CLOSED	CLOSED	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	35	OPEN	OPEN	OPEN	OPEN	OPEN	CLOSED	OPEN	OPEN	CLOSED

NOTES:
1. Operations are extrapolated for tailraces greater than 29 ft due to hardcoded limitations of the model.
2. Operations highlighted yellow are proposed changes current operations.
3. Current operations call for permanent closure FG3-14, FG3-15, FG3-16, FG3-17, and the fixed side entrance weir. These components are greyed out in the figure.

Appendix A

Bradford Island B Branch Fishway Program and Geometry File Evaluation

Memorandum For Record

18 April 2003

To: Bob Buchholz, Chief of Hydraulic Design EC-HD
Stephen Schlenker, Hydraulic Engineer EC-HD, Technical Lead

From: B. C. Cook, Consulting Hydraulic Engineer

Subject: Bonneville “B” Branch Fish Ladder HELCRABS Simulation Model

Objectives:

1. Review methods, equations, and assumptions used in the model.
2. Review program code to verify that these methods, equations, and assumptions are appropriately applied.
3. Review program output and check any questionable items separate calculations.
4. Coordinate compilation and plotting of geometry by EC-HD staff.
5. Identify factors that lead to poor or inaccurate simulation results.
6. Prepare memorandum for record

1.0 “B” Branch Fish Ladder Components and Description

1.1 Description of Major Components

The “B” Branch Fish Ladder is a component of the Bradford Island Fish Ladder and is common with the “A” Branch until the junction pool at weir # 53 is reached [1], (See Figure No. 1). The “B” Branch then curves around to furnish an entrance for the fish that approach the spillway along the north shore of Bradford Island. The fish ladder entrance has two 6’x10’ sluice gates and a fixed weir facing west and a smaller weir discharging transversely into the spillway flow. Stop logs have been placed in this weir and it is not presently planned to be used as part of the “B” Branch Fish Ladder entrance operations. The attraction water is furnished by two separate Auxiliary Water Supply (AWS) systems, each with an individually controlled tainter gate. This attraction water enters a through trash racks facing the forebay and is screened as it drops into the Equalizing Chamber [2]. Both systems draw on this chamber to supply the attraction water to the ladder. Fish Gate (FV4-4) supplies north AWS and diffusers #29 through #33, located in the collection channel. Only #29 and #30 were in use during the period of data collection and measurements. Diffusers #31-#33 are used primarily during periods of high tailwater. Fish Gate FV4-3 supplies attraction water through the south AWS to diffusers #14 through #28 which are distributed along the length of the cascading portion of the ladder from #8 weir to #44 weir. Diffusers #14-#17 are presently non-operational. The fish surmount the obstacle of Bonneville Dam by navigating a series of cascading overflow weirs from the tailwater to the forebay. The hydraulics of this fish ladder was designed to simulate the rapids of natural rivers and streams.

1.2 “B” Branch Testing

On 17 November, 2003 engineers from CENWP-EC-HD performed hydraulic tests and measurements on the “B” Branch flows. The objective of these tests was to quantify by velocity meters and water surface measurements the continuity of the system and compare this with the Northwest Hydraulics Consultants. (NHC) HELCRABS model for the B Branch. This data is available on the CADD System. The following is a description of the measurements taken and their location:

- Total B Branch outflow taken in the collection channel, upstream of the entrance and downstream of diffuser #29. This flow was computed averaging forty point velocity measurements taken by price meter in the cross section. This set of data represents the total hydraulic outflow of the B Branch.
- The total attraction flow in both legs of the B Branch AWS was measured in the north bulkhead slot and the south bulkhead slot. These two measurements plus the flow coming down the ladder represents the total water flow in the B Branch ladder system. The flow in each of these slots was calculated by averaging 35 point velocity measurements taken with a price meter across each section.
- There was one sluice gate open in the south leg of the B Branch entrance. The flow in this section was calculated by averaging 25 point velocities taken with a price meter in the cross section.
- The north leg of the entrance channel contains both fixed weirs and both were in operation. The flow through the side weir was not measured, but the flow through the fixed weir facing west was measured by averaging 25 point velocities taken just upstream of the main weir. The side weir will be closed for operations in the near future.

BONNEVILLE BRADFORD ISLAND “B” BRANCH FISH LADDER

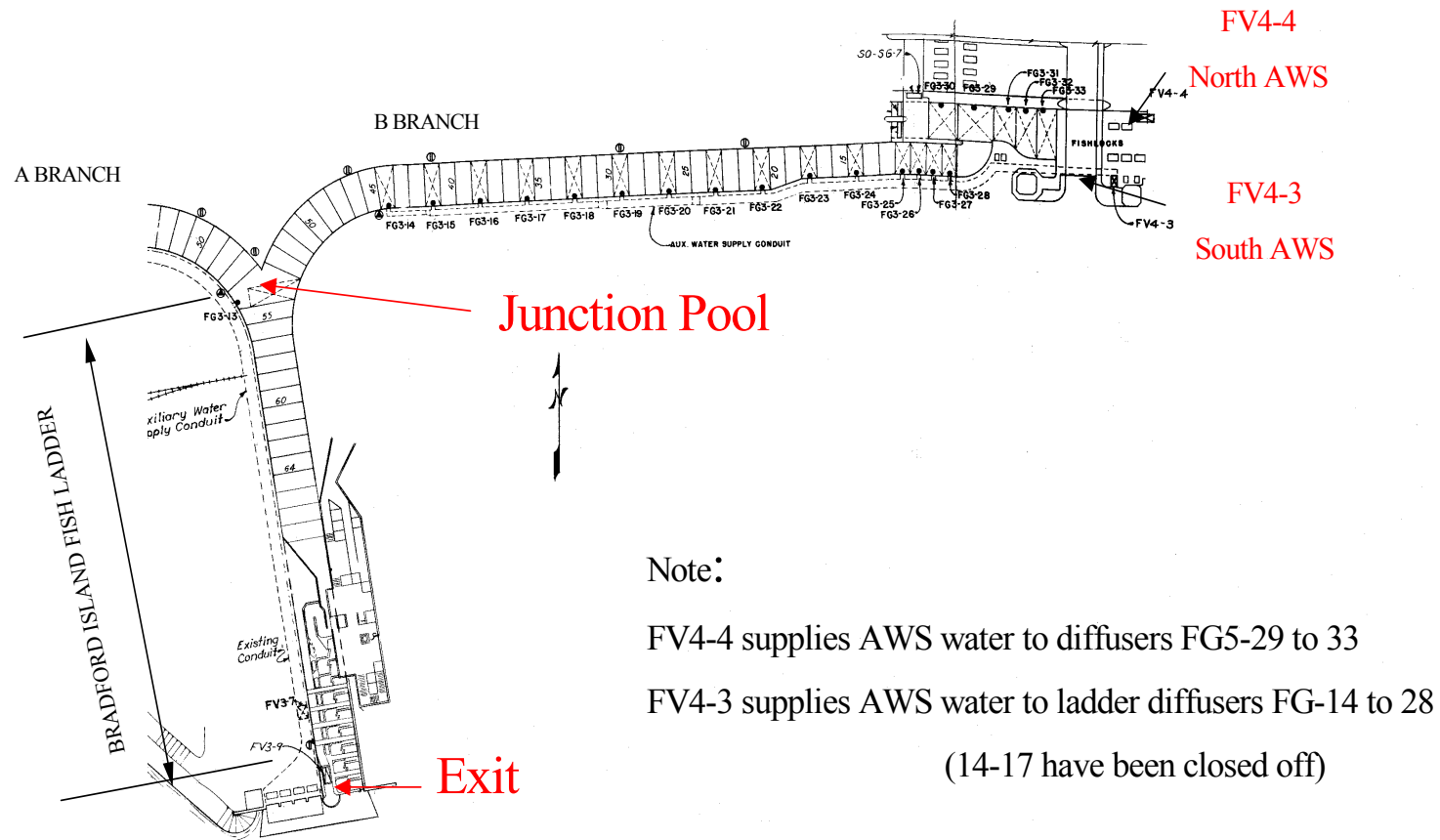


Figure No. 1 B Branch Layout

1.3 Comparison of Measured Flows with HELCRABS Model Flows

The data for this comparison was taken on 11/7/02. The following conditions existed at the time the data was taken.

- Tailwater elevation = 11.52 ft.
- Forebay elevation = 73.90 ft.
- FV4.3 Gate Ht. = 1.5 ft.
- FV4-4 Gate Ht. = 1.9 ft.
- Sluice Gate 4N ---- Completely Open
- Sluice Gate 4S ----- Completely Closed

This data is accessible on the CADD system (Insert Link to CADD). Table No. 1 lists the measured data and the calculated data obtained from the HELCRABS model for the B Branch. The only change from NHC’s original input data set, is that the length of the Main Fixed Weir and the Side Fixed Weir has been modified to reflect the addition of a half-round of 10” pipe welded to the spacers in the weir slot. The length of the Main Fixed Weir was changed to 7.29 ft. and the Side Fixed Weir was changed to 3.54 ft.

1.4 Comments on the Respective Measured and Calculated Data

As indicated in the column delineating the percent of differences, the model badly under estimates the total attraction flow issuing from the entrance weirs and the sluice gate. This indicates that the hydraulic coefficients used in the model need to be calibrated to the physically measured flows. EC-HD has reviewed the HELCRABS program code and checked the entrance calculations.

Table No. 1					
Comparison of B Branch Measured and Model Flows					
LOCATION	Measured Data (cfs or ft)		Model Calc. Data (cfs or ft)	% Difference	Comments
CC Flow	1067		831	22.1%	Model badly under estimates total outflow
Sluice Gate Flow	438		374	14.6%	Model is approx. 20% below measured flow
Main Weir Flow	360		322	10.6%	Model is approx. 9% below measured flow
Side Weir Flow	269		137	49.1%	This measurement was calc. From continuity
C C Head (ft)	1.64		1.95	-18.9%	Model over estimates the head by 7%
AWS North Slot Flow	540		389	28.0%	Model under estimates the AWS flow by 30%
AWS South Slot Flow	526		346.6	34.1%	"
Elev. CC WS (ft)	13.16		13.47	-2.4%	Model over estimates the CC WS by approx. 2%

In general the code is hydraulically and numerically correct. The main discrepancy between the program output and the measured quantities is the selection and size of the hydraulic coefficients for the weirs and slots. There are some instances where NHC and

EC-HD differ in the application or rather the lack of hydraulics and Newton’s second Law, and these will be discussed below.

1.4.1 Computation of Weir Coefficients

NHC’s methodology of computing the entrance weir coefficients has been discussed in several of the previous memoranda evaluating the HELCRAB models. EC-HD has been equally insistent that there is no experimental or physical basis for the “second leg” of the weir coefficient function when the $H_1/P > 2.5$ [3, 9]. This function is a partial cause for the consistent underestimating of the B Branch attraction flows.

The HELCRABS code has a function subprogram that calculates the discharge of a fixed weir in a slot. The computation of the Villemonte submergence factor has two variables that are assigned to the exponents (n,v) of this factor that are read in from the input file. The Villemonte submergence coefficient is:

$$C_v = \left[1 - \left(\frac{H_2}{H_1} \right)^n \right]^v \quad (1)$$

The usual values of these exponents are 1.5 and 0.385 respectively. Rather surprisingly, the input file supplied by NHC assigns a value of 1.4 to the “n” value. This exponent (1.5) on the submergence ratio is derived from the weir equation and is generally regarded as being correct. The “v” exponent was derived from experimental work by Villemonte [3]. It is suggested that the value of the weir exponent be changed to its traditional value in the input file. This is another causal factor of the under estimation of the entrance gates and weirs discharge. The statement that computes the slot discharge does not use the input file “n” value. The correct value of 1.5 is “hard wired” into the code of the statement computing the value, and is thus changeable only by being able to recompile the code.

1.4.2 Weir Lengths and Contraction Coefficients

Within the past couple of seasons, a half-round of ten inch pipe has been welded to the side braces of the spacers in the fixed weir slots. This was a modification to the weirs to help the migration of the eels. This has effectively reduced the length of each of the entrance weirs. This modification was changed in the NHC input file.

- Main Fixed Weir: $L = 7.29$ ft.
- Side Fixed Weir: $L = 3.54$ ft.

The Contraction Coefficients for the weirs are also another parameter that directly affects the calculation of flow and discharge. The weir equation reflects directly the effect that the length and the contraction coefficient (C_c) has on the calculation of the discharge.

$$Q = C(5.35)C_v H_1^{1.5} L(1 - C_c) \quad (2)$$

Most hydraulic texts and handbooks recommend the following adjustment to the weir length for a contracted weir [13].

$$C_c = \frac{n_c H}{10} \quad (2a)$$

Where
 n_c = Number of contractions
 H = Head on crest of the weir
 C_c = Contraction coefficient

There is a caveat on the use of this contraction coefficient and it is that $H < L/3$ [13]. The “sticky” point being that most of the weirs used at fishway entrances are submerged weirs and these relationships were developed for weirs whose nappe’s were well ventilated.

If the effective length of the weir is reduced by a factor of 20% to 30% the calculated discharge will be reduced by the same factor. The B Branch users manual [5], (p. 12) indicates that the contraction coefficients were calibrated from measurements taken during site visits. The contraction coefficients that are in the NHC supplied input data are ten times larger than the coefficients listed in the Users Manual.

TABLE NO. 2 Comparison of Contraction Coefficients					
Source	Fixed Main Weir	Fixed Main Weir	Fixed Side Weir	North Sluice Gate	South Sluice Gate
NHC Users Manual	0.02	0.02	0.03	0.01	0.02
NHC Input Data	0.2	0.2	0.3	0.1	0.1

This goes a long way in explaining why the HELCRABS Model using the NHC supplied input data underestimates the flow across the entrance structure, including both weirs and sluice gates.

1.4.3 Evaluation of Cross Beams on Entrance Weir Flow

The entrance slot containing the fixed entrance weir has two beams that span the slot. These beams are at elevation 17 and 29 ft. respectively. If the water surface in the collection channel is greater than these elevations, these beams will interfere with the discharge across the fixed weir. NHC has an algorithm that adds the width of the beam to the weir whenever the elevation of the water surface is greater than the top of the beam. EC-HD (Schlenker) [] has suggested the standard vertical slot equation. Another suggestion for an algorithm that will reflect the interference of the beams with the flow has been derived and has been calculated and compared with the standard vertical slot equation. Figure No. 2 shows the general hydraulic schematic. The method is to integrate across the flow section, omitting the width of the beams when they are in the cross sectional flow. The total section is divided into three areas.

1. The first is from the crest of the weir to the bottom of the first beam.
2. The second is from the top of the first beam to the bottom of the second beam.
3. The third, is from the top of the third beam to elevation 35, which is the maximum tailwater elevation.

**Integration of Weir Flow
 for
 Cross Beams in "B" Branch Fish Ladder
 Entrance**

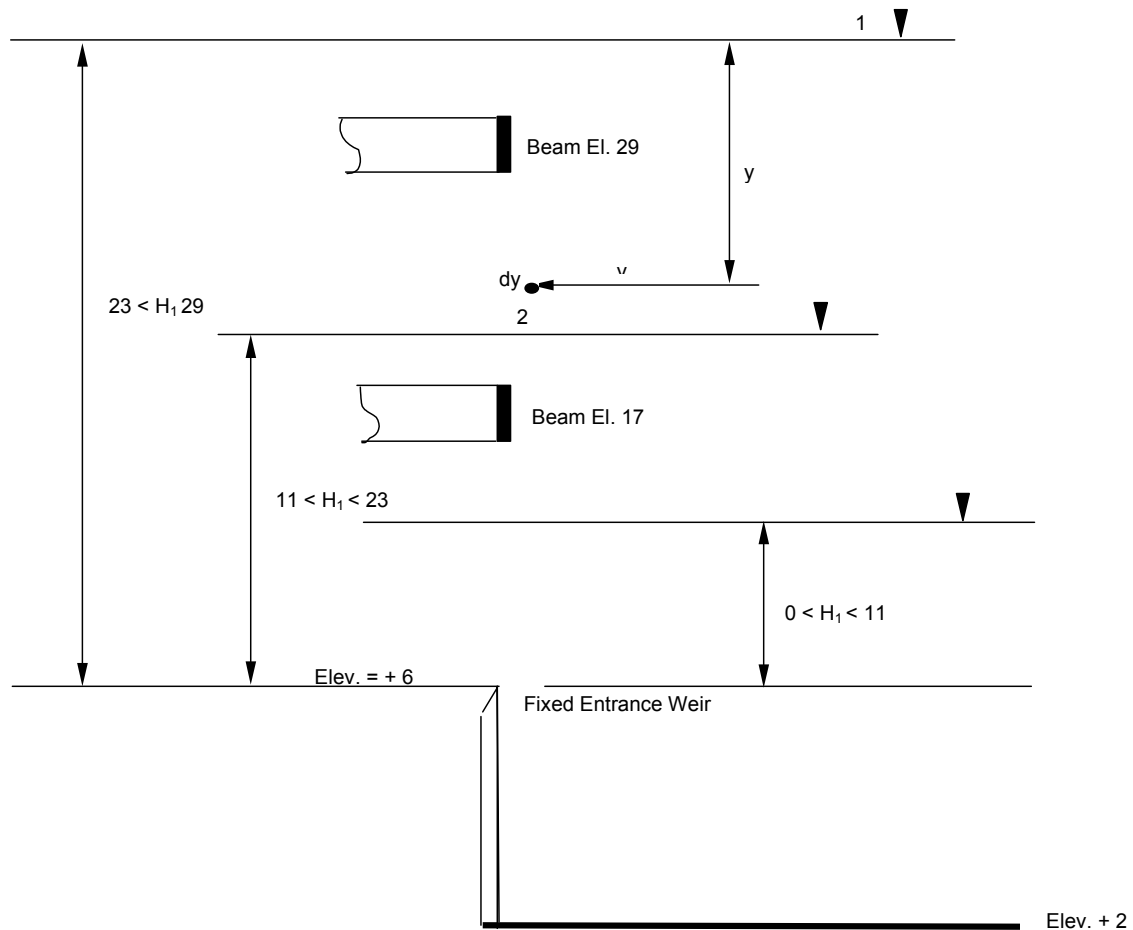


Figure No. 2 Integration Schematic for Cross Beam Interference

If H_1 is ≤ 11

$$q = \int_0^{H_1} 2gy^{1/2} dy \quad (3)$$

$$Q = CC_v 5.35L(1 - C_c)H_1^{1.5} \quad (4)$$

If $11 < H_1 < 23$

$$q = \int_0^{11-w/2} 2gy^{1/2} dy + \int_{11+w/2}^{H_1} 2gy^{1/2} dy \quad (5)$$

$$Q = CC_v 5.35L(1 - C_c) \left[\left(11 - \frac{W}{2}\right)^{1.5} + H_1^{1.5} - \left(11 + \frac{W}{2}\right)^{1.5} \right]$$

If $23 < H_1 < 29$

$$q = \int_0^{11-w/2} 2gy^{1/2} dy + \int_{11+w/2}^{23-w/2} 2gy^{1/2} dy + \int_{23+w/2}^{H_1} 2gy^{1/2} dy \quad (6)$$

$$Q = CC_v 5.35L(1 - C_c) \left[\left(11 - \frac{W}{2}\right)^{1.5} + \left(23 - \frac{W}{2}\right)^{1.5} - \left(11 + \frac{W}{2}\right)^{1.5} + H_1^{1.5} - \left(23 - \frac{W}{2}\right)^{1.5} \right] \quad (7)$$

Where

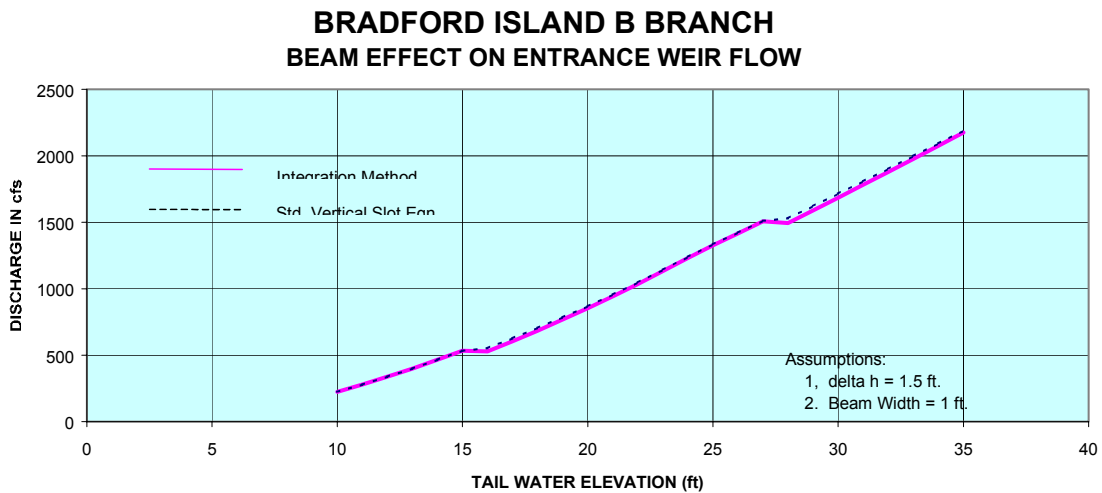
y = Variable of integration
C = Weir Coefficient (efficiency)
Cv = Villemonte submergence factor
L = Length of Weir
W = Width of Beam interfering with the flow
Cc = Contraction coefficient

In essence each of these piecewise equations integrates the flow across the section from the crest of the weir to the water surface in the collection channel. The limits of integration leave out the width of a beam if it is in the cross sectional flow. The submergence factor and the weir coefficient and the length of the weir are included in the algebraic equation below each integral. The results of this algorithm are shown in Figure No. 3 Effects of Cross Beam on Entrance Weir Flow.

The procedure and algorithm used by NHC does not handle the cross sectional flow and the head exponent properly. EC-HD [8, 9] examined this very thoroughly and has proposed the standard vertical slot equation shown below.

$$Q = CC_v 5.35L(1 - Cc) * (H_1 - beam_width) * H_1^{0.5} \quad (8)$$

These Integration and the Standard Slot equation were calculated and plotted over tailwaters ranging from 10-35 ft. The results of these calculations are shown in Figure No. 3. Graphically the two equations practically plot on top of each other. It seems evident that the two equations are derived from the same root. The Standard Slot Equation is a much simpler equation, since it only requires subtracting the total width of beams in the flow section from the variable H_1 . When modifying the HELCRABS code, it is recommended that the Standard Slot Equation be the choice for computing the B Branch Entrance flows.



1.4.4 Calculation of the Entrance Gates Discharge

The model also under estimates the flow from the entrance gates. Table No 1 indicates that the measured discharge is 20% greater than the amount calculated by the model. There seems to be two factors causing this underestimation.

1. The NHC input contraction coefficient is ten times greater than the value shown in the Users Manual.
2. The second factor that reduces the gate discharge is the equation used by NHC in computing the flow [5, p8].

$$Q = C_0 A (2gh_0)^{0.5} \quad (9)$$

Where

$$Q = \text{Discharge}$$

$$C_0 = \text{Discharge Coefficient for Orifice}$$

$$A = \text{Flow Area (based on } d/s \text{ head)}$$

$$h_0 = \text{Differential in Water Surfaces}(H_1 - H_2)$$

EC-HD recommends that the better equation would be equation (5-3) from the *Fish Passage Manual* [],

$$Q = C_D W H_1 \sqrt{2g(H_1 - H_2)} \quad (10)$$

The main difference between these two equations is the definition of the flow area and the discharge coefficient. In the case of the flow area the fish passage manual bases this on the upstream head H_1 , while the NHC equation bases it on the downstream head H_2 . Also the NHC equation has a fixed $C_D = 0.65$ and the *Fisheries Handbook of Engineering* [11] suggest that a $C_D = 0.75$ be used.

Although these documented differences in the coefficients and equations do not explain all the variance between the computed values and the measured values, if the coefficients are adjusted to reflect the measured values they certainly should bring the differences down to a statistical level that is not unusual for measured and calculated hydraulic data.

1.4.4 Collection Channel and Lower Weirs (#8-#53)

The attraction water for the B Branch is delivered to the system through two separate AWS systems (see Figure No. 3). The north AWS system flow is controlled by FV4-3, located in the equalization chamber. This system furnishes flow to diffusers #29-#33, although #31-#33 are used when the tailwater is above elevation 29.0. The south AWS system is controlled by FV4-4. This system furnishes the flow to diffusers #18-#28, and this system also has diffusers #14-#17 blocked off. The source of this attraction water is the forebay. The flow comes through the trash racks on the intake structure, and passes through screens and down into the equalization chamber. Both of the fish valves are seated in the invert of the equalization chamber, therefore the only hydraulic losses up to the gates are those created by the trash rack at the entrance; the screens; turbulence loss and pier and column losses in the equalization chamber. During the tests of 11/07/02, diffusers #29 and #30 were operating from the north AWS, and diffusers #27 and #28 were operating from the south AWS.

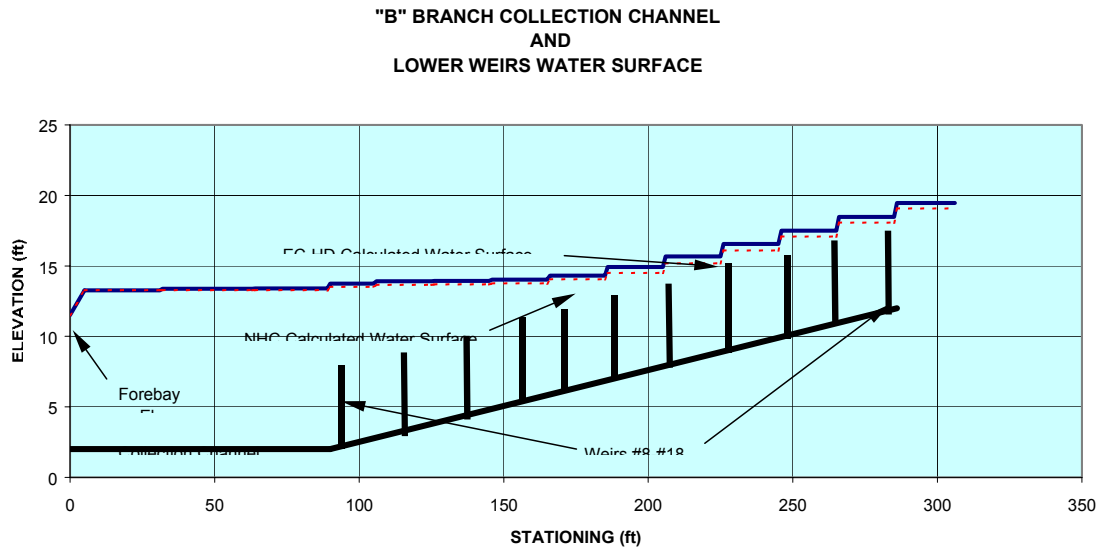


Figure No. 2 Water Surface

In order to check the methodology of the computation of the water surface in B Branch collection channel and the lower overflow weirs, EC-HD prepared Figure No. 2 to compare the two sets of calculations. The following is a summary of the results. The boundary conditions of EC-HD were taken as the same as computed in the sample HELCRABS run using the measure data conditions.

1. The HELCRABS model does not utilize the principles of Spatially Varied Flow (SVF). This has been pointed out on all other model evaluation memorandum. The collection channel is analyzed as Gradually Varied Flow (GVF), but this presumes that the flow is *steady nonuniform* flow. However due to the diffusers, the flow is changing from section to section and the flow is *unsteady nonuniform* [12].
2. The HELCRABS model uses a constant weir coefficient ($C=4.5$). The EC_HD calculations utilized the Rehbach equation [3].

The water surfaces are quite close and similar in their respective shapes. The elevations varied approximately 0.4 ft. due to the inflow from the diffusers #29 and #30. The elevation of the tailwater and the head across the entrance was sufficient to cover the non-overflow section of the lower weirs. This indicated that NHC was correctly using the Villemonte [3] submergence coefficient to compute the up stream water surface at each weir. Continuing up the ladder both water surfaces soon were below the top of the non-overflow section and the flow was limited to the overflow section of the fish ladder weirs and by the time the computations had gotten to the weir #15, the ladder flow was the usual with an approximate one foot fall across each weir.

1.5 Hydraulic Evaluation of the B Branch AWS System

The B Branch Auxiliary Water Supply System receives this attraction water from the forebay. The inlet structures have trash racks and are further protected by screens before dropping into the equalization chamber. The profiles of both the North AWS and the South AWS are depicted in Figures No. 3 and No. 4. The lip of the tainter gates that control the flow into these conduits are at elevation +4.0 which is the floor of the equalization chamber and the conduits go down to elevation –27 (NVD) on the north and –11 (NVD) on the south. The Control System is programmed to maintain a 1.0 to 1.9 ft. of head across the entrance weir. This is accomplished with FV4-4, which is the control valve for the north AWS. Another component of the Control System maintains a differential pressure of 4.16 to 6.0 psi between the south AWS conduit and the water surface in the fish ladder.

1.5.1 NHC’s Simulation Methodology

NHC has chosen to use the commercial pipe network program Kentucky Pipes (K-pipes, developed at the University of Kentucky) to simulate the pressure flow AWS system []. These commercial pipe network programs require the system be defined as circular pipes. The conversion of the prismatic cross section of the B Branch AWS conduits to circular pipes was accomplished by equating the hydraulic radius of the prismatic conduits to $D/4$, the hydraulic radius of circular pipes. This is the standard practice when friction is the main source of head loss. The south AWS probably fits this criteria, however the north AWS is much shorter and the minor losses are the main causal factor in the head losses. If the velocity head is considered since the minor losses are defined in terms of the velocity head, the diameters of the pipes should be based on equivalent areas. In other words the area of the prismatic conduit should be the same as the circular pipe.

- Equating Hydraulic radii

$$D_{\text{pipe}} = 4 \times R_{\text{conduit}}, \quad (11)$$

Where $R = A/P$

- Equating Areas

$$D = \sqrt{\frac{4A}{\pi}} \quad (12)$$

A = area of AWS conduit

D = Dia. Required by K-pipes

Since the north AWS is approximately 200 ft. in length, and the effective length of the south AWS is approximately 400 ft., there is sufficient justification in selecting the pipe diameters on the basis

Bonneville B Branch Profiles North and South AWS

DEVELOPED PROFILES OF “B BRANCH”
AUXILLIARY WATER SUPPLY SYSTEMS
(NOT TO SCALE)

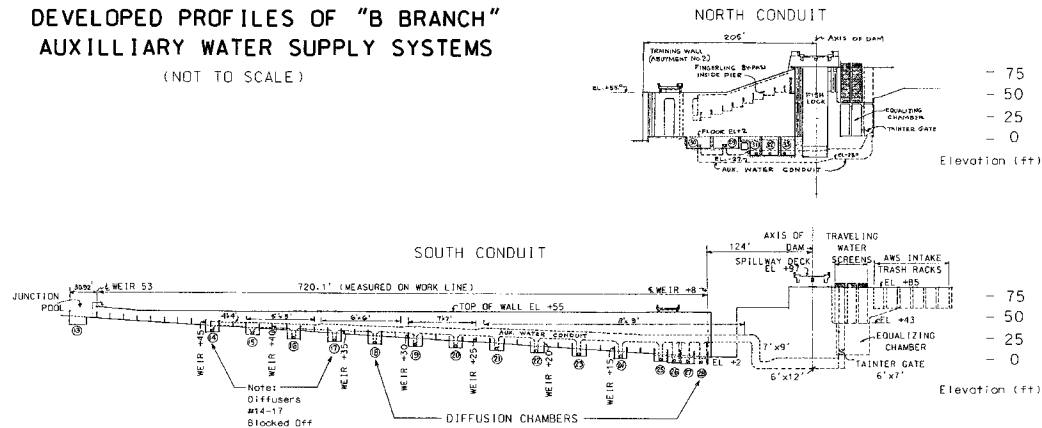


**Figure No. 3 B Branch North and South AWS Profiles
(Larger Scale figure in Progress)**

of equal areas. Please note the effective length of the south AWS is the result of closure of diffusers #14 through #17. Table No 3 shows the suggested lengths and diameters. These lengths and diameters are based on equating the circular areas with the prismatic areas contained in the B Branch prototype.

K-pipes program.

1.5.2 Suggested Changes to K-pipes Input

Since most of the losses in the AWS system are what may be considered minor losses, the method of simulating the system geometry may give better results if the diameter of the pipes were selected on a basis of area rather than the hydraulic radii. Table No. 3 Changes to K-pipes Input Geometry Files, is shown below.

1.6 Recommended Code and Input File Changes for Entrance Hydraulics

Since additional testing of the B Branch during a high tail water event is scheduled, conclusions and recommendations will be tentative until this data can be analyzed and evaluated. The B Branch HELCRABS model appears to be able to simulate the ladder with some changes in geometry and coefficients. The present input data tends to under estimate the flow through the system. Details changes are presented below.

1.6.1 Fixed Weirs in a Slot

- a. **Change the code to reflect EC-HD weir coefficient calculations**
- b. **Change the Villemonte exponent in input file from 1.4 to 1.5**

1.6.2 Sluice Gates North and South

- a. **Make the coefficient of discharge (C_D) a variable. It is now “hardwired” in the code at 0.65.**
- b. **Change the computation of the area in the orifice equation to reflect the upstream area as a function of H_1 .**

1.6.3 Weir Contraction Coefficients

The lengths of the weirs and the widths of the sluice gates directly affect the discharge calculations. There is an existing difference between NHC’s *Users Manual* and the input file supplied by NHC. The measured data of 11/7/02 does not seem to support the contraction coefficients presently in the input file.

- a. **Change the input file Contraction Coefficients (C_c) to conform with the values recommended in the *Users Manual*.**
- b. **Continue testing to determine these site specific values.**

1.6.4 Collection Channel and Ladder Weirs

- a. Change the code to reflect the spatially varied flow (SVF). This methodology should be used if the flow in the channel is not steady flow.**
- b. Change the methodology of computing the ladder weir coefficients to reflect the H_1/P ratio. This is especially true for the lower weirs in the ladder that are much more frequently submerged. The present code fixes the weir coefficient to 4.5.**

HELCRABS – Evaluation of “B” Branch NHC Simulation Program

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TABLE NO. 3
B Branch Network Changes
K-Pipes Input Values

K-Pipes			NHC Values			AS BUILT GEOMETRY			EC-HD Values		
Network Values			equal R						equal A		
Link	Begin	End	Length	Diameter	Minor Loss	Rectangular	Conduit	Conduit	Length	Diameter	Minor Loss
	Node	Node	(ft.)	(in.)	K	Width (ft.)	Height (ft.)	Area	(ft.)	(in.)	K
1	0	1	85	180	Variable	FV4-4 Tainter Gate			85	180	Variable
2	1	2	4	84	16.929	6.000	7.000	42	4	87.753	16.929
3	2	3	36	91.5	1.9	6.000	12.000	72	36	114.895	1.9
4	3	4	90	96	0.07	6.000	12.000	72	90	114.895	0.07
5	4	0	3	36	2.5	3.000	3.000	9	3	40.622	1.5
6	4	5	18	96	0.1	6.000	12.000	72	18	114.895	0.1
7	5	0	3	36	2.5	3.000	3.000	9	3	40.622	1.5
8	5	6	16	96	0.1	6.000	12.000	72	16	114.895	0.1
9	6	0	3	36	2.5	3.000	3.000	9	3	40.622	1.5
10	6	7	35	86.4	0.1	9.000	4.000	36	35	81.243	0.1
11	7	0	13	36	2.5	3.000	3.000	9	13	40.622	1.5
12	7	8	25	86.4	0.1	9.000	4.000	36	25	81.243	0.1
13	8	0	13	36	2.5	3.000	3.000	9	13	40.622	1.5
14	1	12	6	84	Variable	FV4-3 Tainter Gate			6	84	Variable
15	12	13	24	106	2.3	6.000	12.000	72	24	114.895	2.3
16	13	14	70	96	1.3	8.000	9.000	72	70	114.895	1.3
17	14	15	15	101.6	2.3	8.000	9.000	72	15	114.895	2.3
18	15	16	60	101.6	0	8.000	9.000	72	60	114.895	0
19	16	280	23	64	0	8.000	4.000	32	23	76.597	0
20	280	0	1	36	2.5	3.000	3.000	9	1	40.622	2.5
21	16	17	16	101.6	0.1	8.000	9.000	72	16	114.895	0.1
22	17	270	22	64	0	8.000	4.000	32	22	76.597	0
23	270	0	1	36	2.5	3.000	3.000	9	1	40.622	2.5
24	17	18	16	101.6	0	8.000	9.000	72	16	114.895	0
25	18	260	21	64	0	8.000	4.000	32	21	76.597	0
26	260	0	1	36	2.5	3.000	3.000	9	1	40.622	2.5
27	18	19	16	101.6	0.1	8.000	9.000	72	16	114.895	0.1
28	19	250	20	64	0	8.000	4.000	32	20	76.597	0
29	250	0	1	36	2.5	3.000	3.000	9	1	40.622	2.5
30	19	20	48	101.6	0.1	8.000	9.000	72	48	114.895	0.1
31	20	240	19	64	0	8.000	4.000	32	19	76.597	0
32	240	0	1	36	2.5	3.000	3.000	9	1	40.622	2.5
33	20	21	48	101.6	0.1	8.000	9.000	72	48	114.895	0.1
34	21	230	18	64	0	8.000	4.000	32	18	76.597	0
35	230	0	1	36	2.5	3.000	3.000	9	1	40.622	2.5
36	21	22	48	101.6	0.1	8.000	9.000	72	48	114.895	0.1
37	22	220	17	64	0	8.000	4.000	32	17	76.597	0
38	220	0	1	36	2.5	3.000	3.000	9	1	40.622	2.5
39	22	23	48	101.6	0.1	8.000	9.000	72	48	114.895	0.1
40	23	210	16	64	0	8.000	4.000	32	16	76.597	0
41	210	0	1	36	2.5	3.000	3.000	9	1	40.622	2.5
42	23	24	24	84	0.1	7.000	7.000	49	24	94.784	0.1
43	24	25	24	84	0	7.000	7.000	49	24	94.784	0
44	25	200	15	61	0	7.000	4.000	28	15	71.650	0
45	200	0	1	36	2.5	3.000	3.000	9	1	40.622	2.5
46	25	26	48	84	0.1	7.000	7.000	49	48	94.784	0.1
47	26	190	14	61	0	7.000	4.000	28	14	71.650	0
48	190	0	1	36	2.5	3.000	3.000	9	1	40.622	2.5
49	26	27	24	72	0.1	6.000	6.000	36	24	81.243	0.1
50	27	28	24	72	0	6.000	6.000	36	24	81.243	0
51	28	180	13	57	0	5.000	4.000	20	13	60.555	0
52	180	0	1	36	0	3.000	3.000	9	1	40.622	0
53	28	29	48	72	0.1	6.000	6.000	36	48	81.243	0.1
54	29	170	12	57.6	0	5.000	4.000	20	12	60.555	0
55	170	0	1	36	2.5	3.000	3.000	9	1	40.622	2.5
56	29	30	24	60	0.01	5.000	5.000	25	24	67.703	0.01
57	30	31	24	60	0	5.000	5.000	25	24	67.703	0
58	31	160	11	53.3	0	4.000	4.000	16	11	54.162	0

HELCRABS – Evaluation of “B” Branch NHC Simulation Program

9/3/2003 3:10 PM

TABLE NO. 3 (Cont'd) B Branch Network Changes K-Pipes Input Values											
59	160	0	1	36	2.5	3.000	3.000	9	1	40.622	2.5
60	31	32	48	60	0.1	5.000	5.000	25	48	67.703	0.1
61	32	150	10	48	0	4.000	4.000	16	10	54.162	0
62	150	0	1	36	2.5	3.000	3.000	9	1	40.622	2.5
63	32	33	24	48	0.1	4.000	4.000	16	24	54.162	0.1
64	33	34	24	48	0	4.000	4.000	16	24	54.162	0
65	34	140	9	48	0.8	4.000	4.000	16	9	54.162	0.8
66	140	0	1	36	2.5	3.000	3.000	9	1	40.622	2.5
67	16	0	1	36	0.1			0	1		0.1
Notes: 1 Link 11 is comprised of a 10' section that measures 4' x 3' and a 3' section that measures 3' x 3'. 2 Link 13 is comprised of a 10' section that measures 4' x 3' and a 3' section that measures 3' x 3'. 3 Link 19 is comprised of a 2' section that measures 4' x 8' and a 22'10" section that measures 8'2" x 7'. 4 Link 22 is comprised of a 2' section that measures 4' x 8' and a 21'10" section that measures 7'10" x 7'. 5 Link 25 is comprised of a 2' section that measures 4' x 8' and a 20'10" section that measures 8'2" x 7'. 6 Link 42 is comprised of an 8' section that measures 7' x 7' and a 16' section that measures 9' x 8'. 7 Link 49 is comprised of an 8' section that measures 6' x 6' and a 16' section that measures 7' x 7'. 8 Link 56 is comprised of a 8' section that measures 5' x 5' and a 16' section that measures 6' x 6'. 9 Link 63 is comprised of an 8' section that measures 4' x 4' and a 16' section that measures 5' x 5'.											

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Appendix B

Meeting Minutes and Trip Reports

Item 1: November 7,2002 Data Collection Report

MEMORANDUM FOR RECORD

FROM: Sean Askelson

SUBJECT: Report on data collection on the B Branch of the Bradford Island Fishladder November 7, 2002

DATE: November 20, 2002

Attendees: Sean Askelson, EC-HD
Jacob Macdonald, EC-HD
Kyle McCune, EC-HD
Teresa Morales, EC (EIT)
Laurie Rice, EC-HD
Steve Schlenker, EC-HD

Trip Objectives:

1. Collect data to verify the Bradford Island B Branch Fish Ladder HELCRABS numerical model under a fixed forebay and tailrace condition.
2. Investigate the feasibility of using an Acoustic Doppler Current Profiler (ADCP) for future fishway measurements.

Data Collection:

The team arrived at the project and organized at the B Branch Entrance at 9:00 AM. Fixed forebay and tailrace conditions were coordinated with the Reservoir Control Center (RCC) for 10:00 AM to 4:00 PM prior to the visit and therefore data collection was to begin at 10:00 AM. Data was collected from four locations: The intake for the North and South Auxiliary Water Supply (AWS) systems, the south bay of the Entrance (fixed weirs), the North Entrance (sluice gates) and the approach channel to the entrances. The general layout of the B Branch system and the locations where measurements took place are provided in Figure 1 of this report.

The forebay ranged from 73.7' to 73.8', the tailwater ranged from 11.6' to 11.3' and the entrance head ranged from 1.5' to 1.8' during the testing period.

Fishladder Flow

Bonneville A and B Branch share a common ladder exit. The flow in the upper common section of the ladder was not directly measured this trip. Measurements have been taken during A Branch tests for both 1.0' and 1.3' head on the picketed lead. The flow rates are 212 cfs and 262 cfs respectively. It is assumed there is an equal distribution of flow between the A and B Branches. The head on the picketed lead during this test was 1.0' so the flow from the upper section of the ladder is about 106 cfs.

Entrance Approach Channel

The location the flow was measured in the approach channel was downstream of the last diffusers and upstream of the fishladder entrances. Measuring at this location should encompass the total flow in the fishladder, which equals the total combined discharge from the entrances. This is considered the most accurate flow measurement taken due to the well-developed flow pattern and relatively slow velocity. The total discharge at this location was 1067 cfs.

Fishladder Entrances

The south bay of the Entrance consists of two sluice gates: SG 4N and SG 4S. SG 4N was open and SG 4S was closed during this test. The flow in the South Entrance was 438 cfs.

The north bay of the Entrance consists of a main fixed weir directed to the west (downstream in the tailrace) and a side fixed weir to spill bay #23. The flow in the main fixed weir was 360 cfs.

The side weir Entrance was open during the testing, but we are unable to access this site for measurements. Assuming continuity between the approach channel and the other openings, the flow through the side weir would be 269 cfs.

AWS Intake

The AWS intake was sampled at two bulkhead slots just upstream of the trashracks feeding the North and South AWS channels. Measurements at this location would not provide the flow distribution between the North and South AWS branches, but will provide the overall flow through the AWS system. The measurements were to be taken with an Acoustic Doppler Velocimeter (ADV) mounted on a lead fish and lowered into the slot. Due to problems with a converter plug between the ADV and the laptop, we were not able to communicate with the ADV. The measurements were taken with a Price meter instead. The flow was well developed and the fish did not translate much in the slot. The total AWS flow measured was 1065 cfs.

Discharge Calculations:

The total flow through the various sampling transects is determined by first calculating an integrated average velocity across the channel at each depth and then integrating the resultant averages again over all depths. The edge of the flow field was extrapolated linearly from the two outermost measurements at a given depth. If the extrapolated value at a channel edge would be greater than the two measure values used to extrapolate it that velocity would be set to the adjacent measurement. The total integrated average velocity was then multiplied by the total cross-sectional area to get a total flow rate.

Table 1. Summary of Flow

Flow Exiting System		Flow Entering System	
	Flow (cfs)		Flow (cfs)
Entrance Approach Channel	1067	AWS North Slot	540
Sluice Gate	438	AWS South Slot	526
Main Fixed Weir	360	subtotal AWS	1066
Side Weir	269(est.)		
		Fishladder Flow	106(est.)
ENTRANCE DISCHARGE	1067	INFLOW DISCHARGE	1172
	Difference	105 cfs	
	% Difference	10%	

The table above lists the measurements taken during this round of testing. The difference between the AWS and ladder measurements and the Approach channel measurement is about 105 cfs, or 10% difference. The AWS measurements at the bulkhead slots may be overestimating the flow. The AWS channel approaching the bulkhead slot slopes down from el. 40 to el. 50 at the bulkhead slot. The velocities measured may have a downward component associated with them that could result in high price meter readings. This could contribute to the difference in flow measured between the AWS and the Approach Channel.

Conditions during this site visit will be used as input into the HELCRABS B Branch Fishway model. Results from the model run will then be compared to the actual flows measured in order to determine whether deficiencies exist in the model.

ADCP Results

We had a couple of goals for the ADCP. First was to find a quicker and possibly more accurate way of collecting data. In theory, what could take an hour measuring spot velocities in a channel with a price meter or an ADV could be done in a fraction of the

time with the ADCP and possibly yield more accurate results. This could reduce the time spent taking data, reduce the number of people in the field, or increase the number of measurements taken during our testing window to get a better picture of what is going on in the prototype. Second, we could verify the results we were getting with the ADV and price meter.

Unfortunately, we were not able to obtain any useful information from the ADCP during this field measurement trip. We had taken the ADCP out in the field and experimented with the instrument and software earlier in the week. We had been successful setting up and communicating with the instrument, but we were not versed enough in the software and deployment of the ADCP to take meaningful data. There are a number of possible reasons we did not obtain useful data, but it would only be speculation on my part.

Now that we have some familiarity communicating with the ADCP and working with the software, We feel it would be beneficial to spend a little time with someone who has used the instrument before to figure out what we had done wrong, or get ideas for future testing. We have a good understanding of what it will take to maneuver the instrument into position and hold it there, but we still do not know the proper software setup to take useful data. We will eventually have to return the instrument to the WES facility. At that time it may be possible to get someone from the WES facility in North Bonneville to set it up and quickly show us how to take a measurement, or walk us through the planning steps so we would be able to take accurate measurements next time.

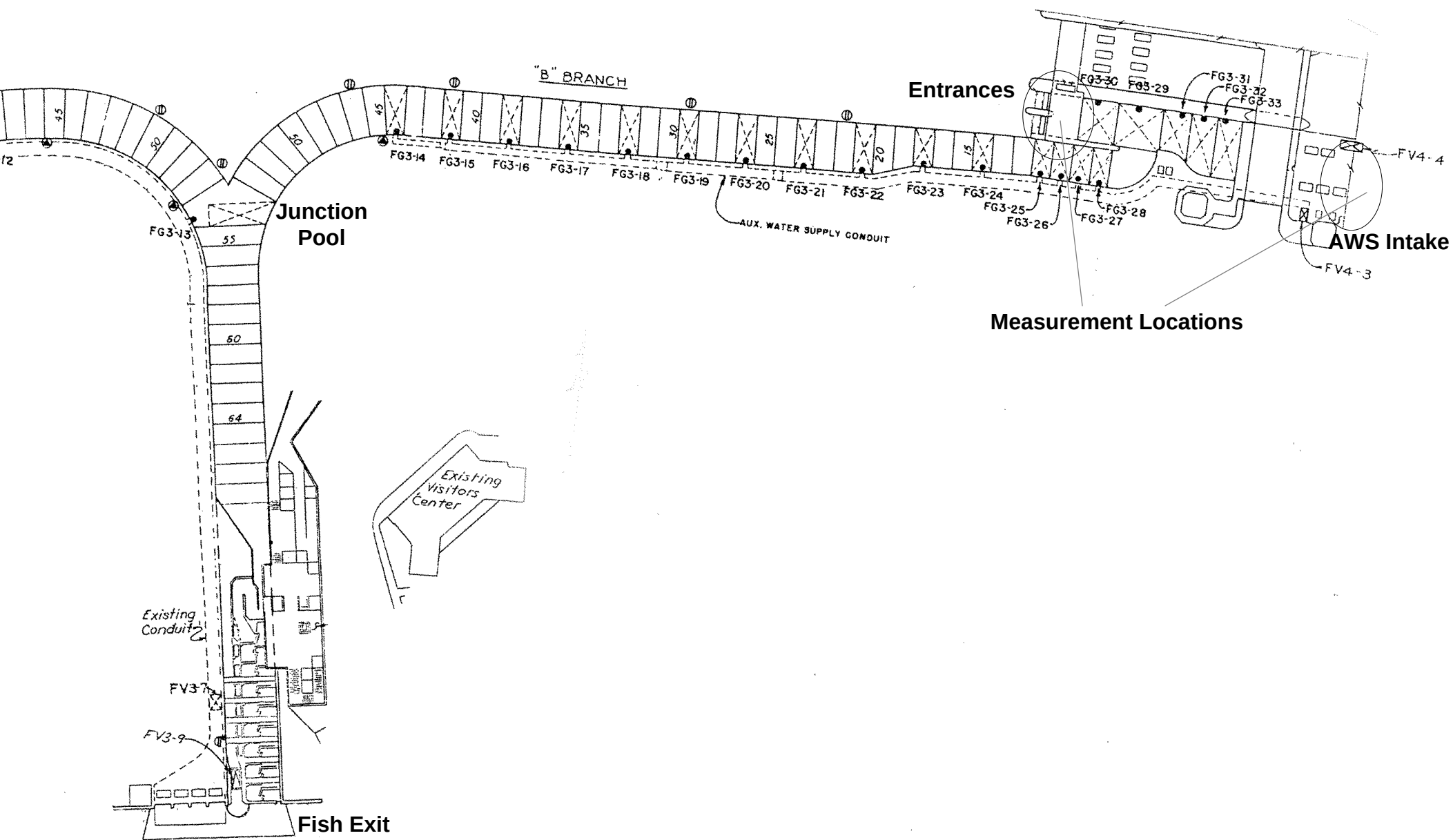


Figure 1
Bradfor Island B Branch
Measurement Locations
November 7, 2002

AWS INTAKE BULKHEAD SLOT MEASUREMENTS
NORTH SLOT 1

Data Collectors:

JM

KM

SA

TEST NAME:

NORTH AWS SLOT

TEST 1

Date:

11/7/2002

Time:

START

END

13:10

14:00

AWS Intake Tainter Gate Data

Forebay Level =

Tailrace Level =

FG4-3

FG4-4

Opening (ft)

1.50

1.90

Distance to WS d/s of gate (ft)

48.3

47.6

Head d/s of Gate:

36.7

37.4

North

South

1

2

Intake Number from East

AWS INTAKE BULKHEAD SLOT

(Indicate with 'X')

INSTRUMENT

ADV

Ident.

Price Meter

X

Price Meter Rotations per Count =

1

 $V = 0.03 + 2.27548 * (\text{rotations/time})$

slot

POINT VELOCITY AND FLOW MEASUREMENTS IN AWS: Z_{15} = Meas. Distance to WS

11.30

ft (from 85 deck)

WS = Water Surface Elev

73.70

ft (= 85 - Z_{15}) Y = Measured Depth =

23.70

ft (=WS - 60)

B = Channel Width =

15.5

ft

Deck elev =

85.0

ft

Zi = INVERT =

50.0

ft

X1 = Side Edge width inc=

2

Y1 = Vertical edge height incr =

2

weighting factor

0.50

Approx internal dimension =

4.2 ft

Div

Number of Internal X Increments =

3.0

6

Number of Internal Y Increments =

5.0

10

AWS INTAKE MEASUREMENTS

Time:

14:10

15:00

North Bulkhead Slot									
(measured from west side of slot)									
Horiz. No.:	Formula for Depth from Surface (ft)	Depth from Surface (ft)	Vert. Sect. No. :	1	2	3	4	5	Average Integrated Velocity
			Distance From Left Edge (ft)	1.0	4.2	8.5	12.8	16.0	
				0.6	3.5	7.8	12.1	15.0	
1	0.5 * Y1	1.00	Counts	41	40	38	28	32	1.84 ft/s
			duration	45	45	45	45	45	
			VELOCITY	2.10	2.05	1.95	1.45	1.65	
2	Y1 + (Y-2*Y1) * 0.1	4.00	Counts	37	25	29	32	32	1.56 ft/s
			duration	45	45	45	45	45	
			VELOCITY	1.90	1.29	1.50	1.65	1.65	
3	Y1 + (Y-2*Y1) * 0.3	8.00	Counts	28	23	29	38	34	1.56 ft/s
			duration	45	45	45	45	45	
			VELOCITY	1.45	1.19	1.50	1.95	1.75	
4	Y/2	11.90	Counts	25	25	39	38	19	1.61 ft/s
			duration	45	45	45	45	45	
			VELOCITY	1.29	1.29	2.00	1.95	0.99	
5	Y1 + (Y-2*Y1) * 0.7	15.8	Counts	23	30	50	33	27	1.80 ft/s
			duration	45	45	45	45	45	
			VELOCITY	1.19	1.55	2.56	1.70	1.40	
6	Y1 + (Y-2*Y1) * 0.9	19.7	Counts	23	32	29	20	13	1.28 ft/s
			duration	45	45	45	45	45	
			VELOCITY	1.19	1.65	1.50	1.04	0.69	
7	Y - 0.5 * Y1	22.7	Counts	28	28	20	16	13	1.10 ft/s
			duration	45	45	45	45	45	
			VELOCITY	1.45	1.45	1.04	0.84	0.69	
Fish Oreintation									
Total Average Integrated Velocity =				1.47 ft/s					
Total Computed AWS FLOW RATE =				540 cfs		(= B * Y * V)			

ENTRANCE CHANNEL MEASUREMENTS

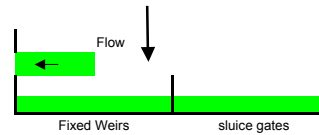
Large Approach Channel to Entrances

Data Collectors:	LR	TM	SJS
-------------------------	----	----	-----

Date: 11/7/2002

Date: 11/7/2002

Time: 13:00



Tailrace Level :

Distance to Water:			WATER LEVEL ELEV:	
start	end	Ref EL	start	end
46.60	46.79	58.11	11.50	11.32
start	end	Ref EL	start	end
45.25	45.32	58.44	13.19	13.12
			1.69	1.80

U/s Channel:

INSTRUMENT

Price Meter	X
-------------	---

Price Meter Rotations per Count = 1

$V = 0.03 + 2.27548 * (\text{rotations/time})$

NORTH AWS DIFFUSERS OPEN:				
30	29	31	32	33
X	X			

SOUTH AWS DIFFUSERS OPEN:									
14	15	16	17	18	19				
							East		
20	21	22	23	24	25	26	27	28	
							X	X	

Sluice Gate Data	
SG 4N	SG 4S
X if Open (if used)	

Fixed Weir Data		
	Main	Side
X if Open (if used)	X	X

WS = Water Surface Elevation =
Y = Measured AWS Channel Depth =
Edge Effort Weighting Factor =

X1 = Side Edge width inc=
Y1 = Vertical edge height incr =

13.19
11.19
0.5

B = Channel Width =
BRIDGE INVERT ELEV. =
Zi = AWS INVERT =

35.0	ff
60.0	ff
2.0	ff

171.479988
est side weir flow
#REF!
2.72

Approx internal dimension =
 Number of Internal X Increments =
 Number of Internal Y Increments =

4.5 ft	Div	
	6.0	12
	3.0	6

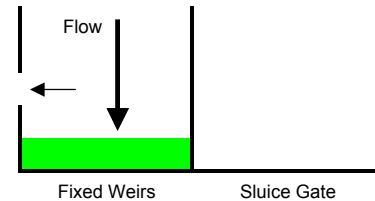
Horiz. No.:	Formula for Distance from surface	Depth from Surface (ft)	Ver Sec	1	2	3	4	5	6	7	8	Average Integrated Velocity
			Distance From Left Edge (ft)	1.5	5.4	10.3	15.1	19.9	24.8	29.6	33.5	
				1.5	5.4	10.3	15.1	19.9	24.8	29.6	33.5	
1	0.5*Y1	1.5	Counts	81	84	81	80	76	61	58	51	
			duration	60	60	60	60	60	60	60	60	
			VELOCITY	3.10	3.22	3.10	3.06	2.91	2.34	2.23	1.96	2.76 ft/s
2	Y1 + (Y-2*Y1)/6	3.9	Counts	81	74	72	77	70	64	64	49	
			duration	60	60	60	60	60	60	60	60	
			VELOCITY	3.10	2.84	2.76	2.95	2.68	2.46	2.46	1.89	2.65 ft/s
3	Y/2	5.6	Counts	79	77	70	70	80	68	69	58	
			duration	60	60	60	60	60	60	60	60	
			VELOCITY	3.03	2.95	2.68	2.68	3.06	2.61	2.65	2.23	2.74 ft/s
4	Y1 + 5* (Y-2*Y1)/6	7.3	Counts	75	82	77	78	76	69	67	50	
			duration	60	60	60	60	60	60	60	60	
			VELOCITY	2.87	3.14	2.95	2.99	2.91	2.65	2.57	1.93	2.77 ft/s
5	Y - 0.5 * Y1	9.7	Counts	68	76	57	78	81	78	72	48	
			duration	60	60	60	60	60	60	60	60	
			VELOCITY	2.61	2.91	2.19	2.99	3.10	2.99	2.76	1.85	2.70 ft/s
Total Average Integrated Velocity =				2.72 ft/s								
Total Computed Entrance Channel FLOW RATE =				1067 cfs (= B * Y * V)								

BONNEVILLE BRADFORD ISLAND "B" BRANCH FISHWAY VELOCITY DATA
ENTRANCE CHANNEL MEASUREMENTS
North Channel to Fixed Weirs

Data Collectors: LR TM SJS

TEST 1

Date: 11/7/2002 Time: Start 10:20 End 11:20



	Distance to Water:			WATER LEVEL ELEV:		
	start	end	Ref EL	start	end	
Tailrace Level :	46.55	46.50	58.11	11.56	11.61	
U/s Staff Gage :	45.24	45.31	58.44	13.20	13.13	
				1.64	1.52	

Slucice Gate Data	
SG 4N Main	SG 4S Side
Open? X	Open? X

INSTRUMENT

Price Meter X

Price Meter Rotations per Count = 1

 $V = 0.03 + 2.27548 * (\text{rotations/time})$
POINT VELOCITY AND FLOW MEASUREMENTS IN ENTRANCE:

Z ₁₅ = Meas. Distance to AWS WS =	42.89	ft (from 56 bridge)	B = Channel Width =	15.0	ft
WS = Water Surface Elevation =	13.10	ft (= 56 - Z ₁₅)	BRIDGE ELEV. =	56.0	ft
Y = Measured AWS Channel Depth =	11.10	ft (=WS - 2)	Zi = AWS INVERT =	2.0	ft
Edge Effort Weighting Factor =	0.5				

 X1 = Side Edge width inc= 2
 Y1 = Vertical edge height incr = 3

 Appox internal dimension = 4.0 ft Div
 Number of Internal X Increments = 3.0 6
 Number of Internal Y Increments = 1.0 2

Horiz. No.:	Formula for Distance from surface	Depth from Surface (ft)	Vert. Sect. No. :	1	2	3	4	5	Average Integrated Velocity
			Distance From Left Edge (ft)	1.0	3.8	7.5	11.2	14.0	
				1.0	3.8	7.5	11.2	14.0	
1	0.5*Y1	1.5	Counts	61	64	69	74	71	
			duration	60	60	60	60	60	
			VELOCITY	2.34	2.46	2.65	2.84	2.72	2.61 ft/s
2	Y1 + (Y-2*Y1)/6	3.9	Counts	42	56	58	69	72	
			duration	60	60	60	60	60	
			VELOCITY	1.62	2.15	2.23	2.65	2.76	2.29 ft/s
3	Y/2	5.6	Counts	51	58	48	66	69	
			duration	60	60	60	60	60	
			VELOCITY	1.96	2.23	1.85	2.53	2.65	2.23 ft/s
4	Y1 + 5* (Y-2*Y1)/6	7.3	Counts	44	48	46	61	66	
			duration	60	60	60	60	60	
			VELOCITY	1.70	1.85	1.77	2.34	2.53	2.02 ft/s
5	Y - 0.5 * Y1	9.6	Counts	33	33	41	54	60	
			duration	60	60	60	60	60	
			VELOCITY	1.28	1.28	1.58	2.08	2.31	1.69 ft/s
Total Average Integrated Velocity =				2.16 ft/s					
Total Computed Channel FLOW RATE =				360 cfs (= B * Y * V)					

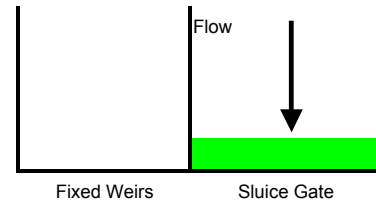
NOTES:

BONNEVILLE BRADFORD ISLAND "B" BRANCH FISHWAY VELOCITY DATA
ENTRANCE CHANNEL MEASUREMENTS
South Channel to Sluice Gates

Data Collectors: LR TM SJS

TEST 1

Date: 11/7/2002 Time: Start 11:20 End 12:45



	Distance to Water:			WATER LEVEL ELEV:		
	start	end	Ref EL	start	end	
Tailrace Level :	46.50	46.61	58.11	11.61	11.50	
U/s Staff Gage :	45.31	45.25	58.42	13.13	13.19	
				1.52	1.69	

Sluice Gate Data	
SG 4N	SG 4S
Open? X	

INSTRUMENT

Price Meter X

 Price Meter Rotations per Count = 1
 $V = 0.03 + 2.27548 * (\text{rotations/time})$
POINT VELOCITY AND FLOW MEASUREMENTS IN ENTRANCE:

Z_{15} = Meas. Distance to AWS WS = 13.00 ft (from 56 bridge)
 WS = Water Surface Elevation = 13.00 ft (= 56 - Z_{15})
 Y = Measured AWS Channel Depth = 11.00 ft (= WS - 2)
 Edge Effort Weighting Factor = 0.5

B = Channel Width = 15.0 ft
 BRIDGE ELEV. = 56.0 ft
 Z_i = AWS INVERT = 2.0 ft

X1 = Side Edge width incr = 2
 Y1 = Vertical edge height incr = 2

Appox internal dimension = 4.0 ft Div
 Number of Internal X Increments = 3.0 6
 Number of Internal Y Increments = 2.0 4

Horiz. No.:	Formula for Distance from surface	Depth from Surface (ft)	Vert. Sect. No. :	1	2	3	4	5	Average Integrated Velocity
			Distance From Left Edge (ft)	1.0	3.8	7.5	11.2	14.0	
				1.0	3.8	7.5	11.2	14.0	
1	0.5*Y1	1.5	Counts	100	76	69	41	31	2.43 ft/s
			duration	60	60	60	60	60	
			VELOCITY	3.82	2.91	2.65	1.58	1.21	
2	Y1 + (Y-2*Y1)/6	3.9	Counts	104	90	68	49	42	2.70 ft/s
			duration	60	60	60	60	60	
			VELOCITY	3.97	3.44	2.61	1.89	1.62	
3	Y/2	5.6	Counts	83	102	68	53	45	2.71 ft/s
			duration	60	60	60	60	60	
			VELOCITY	3.18	3.90	2.61	2.04	1.74	
4	Y1 + 5* (Y-2*Y1)/6	7.3	Counts	23	160	73	49	43	2.80 ft/s
			duration	60	60	60	60	60	
			VELOCITY	0.90	6.10	2.80	1.89	1.66	
5	Y - 0.5 * Y1	9.6	Counts	0	175	67	55	35	2.71 ft/s
			duration	60	60	60	60	60	
			VELOCITY	0.03	6.67	2.57	2.12	1.36	
Total Average Integrated Velocity =				2.65 ft/s					
Total Computed Channel FLOW RATE =				438 cfs (= B * Y * V)					

NOTES: For Vertical Section 4, Horizontal Section 1 FISH ROTATED AT 45° OFF LOGITUDE
 For Vertical Section 4, Horizontal Section 2 FISH ROTATED AT 20° OFF LOGITUDE

BONNEVILLE BRADFORD ISLAND "B" BRANCH FISHWAY VELOCITY DAT

AWS INTAKE BULKHEAD SLOT MEASUREMENTS
SOUTH SLOT 1

Data Collectors: JM KM SA

TEST NAME: SOUTH SLOT AWS

TEST 1

Date: 11/7/2002

Time: START 14:10 END 15:00

AWS Intake Tainter Gate Data

Forebay Level =

	FG4-3	FG4-4
Opening (ft)	1.50	1.90
Distance to WS d/s of gate (ft)	48.3	47.6
Head d/s of Gate:	36.7	37.4

Tailrace Level =

Intake Number from East
AWS INTAKE BULKHEAD SLOT
(Indicate with 'X')

North 1 South 2

INSTRUMENT ADV Ident.

Price Meter X
V = 0.03 + 2.27548 * (rotations/time)

Price Meter Rotations per Count = 1

POINT VELOCITY AND FLOW MEASUREMENTS IN AWS:

Z₁₅ = Meas. Distance to WS 11.30 ft (from 85 deck)
WS = Water Surface Elev 73.70 ft (= 85 - Z₁₅)
Y = Measured Depth = 23.70 ft (=WS - 50)

X1 = Side Edge width inc= 2
Y1 = Vertical edge height incr = 2
weighting factor 0.50

B = Channel Width = 15.5 ft
Deck elev = 85.0 ft
Zi = INVERT = 50.0 ft

Approx internal dimension = 4.2 ft
Number of Internal X Increments = 3.0
Number of Internal Y Increments = 5.0

Div 6 10

AWS INTAKE MEASUREMENTS

Time: 13:10 14:00

North Bulkhead Slot									
(measured from west side of slot)									
Horiz. No.:	Formula for Depth from Surface (ft)	Depth from Surface (ft)	Vert. Sect. No. :	1	2	3	4	5	Average Integrated Velocity
			Distance From Left Edge (ft)	1.0	4.2	8.5	12.8	16.0	
				0.6	3.5	7.8	12.1	15.0	
1	0.5 * Y1	1.0	Count	37	45	41	42	44	2.15 ft/s
			duration	45	45	45	45	45	
			VELOCITY	1.90	2.31	2.10	2.15	2.25	
2	Y1 + (Y-2*Y1) * 0.1	4.0	Count	30	36	30	34	37	1.71 ft/s
			duration	45	45	45	45	45	
			VELOCITY	1.55	1.85	1.55	1.75	1.90	
3	Y1 + (Y-2*Y1) * 0.3	8.0	Count	31	35	35	31	31	1.70 ft/s
			duration	45	45	45	45	45	
			VELOCITY	1.60	1.80	1.80	1.60	1.60	
4	Y/2	11.9	Count	41	39	28	22	13	1.50 ft/s
			duration	45	45	45	45	45	
			VELOCITY	2.10	2.00	1.45	1.14	0.69	
5	Y1 + (Y-2*Y1) * 0.7	15.8	Count	42	33	25	17	12	1.32 ft/s
			duration	45	45	45	45	45	
			VELOCITY	2.15	1.70	1.29	0.89	0.64	
6	Y1 + (Y-2*Y1) * 0.9	19.7	Count	42	31	26	9	15	1.23 ft/s
			duration	45	45	45	45	45	
			VELOCITY	2.15	1.60	1.34	0.49	0.79	
7	Y - 0.5 * Y1	22.7	Count	37	30	22	7	14	1.10 ft/s
			duration	45	45	45	45	45	
			VELOCITY	1.90	1.55	1.14	0.38	0.74	
Fish Oreintation									
Total Average Integrated Velocity =				1.43 ft/s					
Total Computed AWS FLOW RATE =				526 cfs (= B * Y * V)					

BONNEVILLE B BRANCH FISHWAY VELOCITY DATA**FV3-9 Intake (Ladder Augmentation flow)**

Data Collectors: SJS

Date: 11/7/2002 Time:

start	end
	16:30

FV3-9 Tainter Gate Data

Forebay Level =

	73.90
--	-------

Opening (ft)

start	end
	1.10

 Distance to WS d/s of gate (ft)

--	--

Head on Picketed Lead =

	1.00
--	------

Head d/s of Gate:

--	--

INSTRUMENT

Price Meter

Price Meter Rotations per Count =

$$V = 0.03 + 2.27548 * (\text{rotations/time})$$

POINT VELOCITY AND FLOW MEASUREMENTS: Z_{15} = Meas. Distance to AWS WS =

11.10 ft (from 85 level)

B = Channel Width = 9.50 ft

WS = Water Surface Elevation =

73.90 ft (= 85 - Z_{15})

Grating ELEVATION = 85.0 ft

Y = Measured AWS Channel Depth =

10.90 ft (= WS - 63)

Zi = INVERT = 63.0 ft

X1 = Side Edge width incr =

2 ft

Approx internal dimension =

3.0 ft

Div by

Y1 = Vertical edge height incr =

2 ft

Number of Internal X Increments =

2.0

4

Number of Internal Y Increments =

3.0

6

Horiz. No.:	Formula for depthn below surface (pm)	Depth from Surface (ft)	Vert. Sect. No. :	1	2	3	4	Average Velocity
			Est Dist. from Left Edge (ft)	1.0	3.50	6.50	8.00	
			Actual Dist (ft) from Fft side	1.00	3.50	5.75	9.17	
1	0.5 * Y1		Counts					
			duration					
			VELOCITY					ft/s
2	Y1 + (Y-2*Y1)/6		Counts					
			duration					
			VELOCITY					ft/s
3	Y/2		Counts					
			duration					
			VELOCITY					ft/s
4	Y1 + 5* (Y-2*Y1)/6		Counts					
			duration					
			VELOCITY					ft/s
5	Y - 0.5*Y1		Counts					
			duration					
			VELOCITY					ft/s
Total Average Integrated Velocity =				ft/s				
Total Computed FLOW RATE =				cfs				(= B * Y * V)

Item 2: July 2, 2003 Data Collection Report

MEMORANDUM FOR RECORD

FROM: Sean K Askelson

SUBJECT: Report on data collection on the B Branch of the Bradford Island Fish Ladder July 2, 2003

DATE: July 10, 2003

Attendees: Steve Schlenker, EC-HD
Sean Askelson, EC-HD
Jacob Macdonald, EC-HD
Laurie Rice, EC-HD
Paul Williams, EC-HD

Trip Objectives:

Collect data to verify the Bradford Island B Branch Fish Ladder HELCRABS numerical model under a fixed forebay and tailrace condition.

Data Collection:

Data was collected at both A and B Branch fish ladders for this trip. B Branch data was collected first. The team arrived at the project and organized at the B Branch Entrance at 7:00 AM. Tests had been performed B Branch previously on Nov 7, 2002. There were two key differences with this year's test compared to last year: higher tailrace and the side entrance has become permanently closed.

Project assistance was provided throughout the day. The riggers removed the bulkhead slot covers at the North AWS Intake for measurement. Project Biologist Tim Darland and Student Scott Stettler were often on hand to assist us in our flow measurements.

Fixed forebay and tailrace conditions were coordinated with the Reservoir Control Center (RCC) for 7:00 AM to 4:00 PM prior to the visit and therefore data collection was to begin at 7:00 AM. Data was collected from five locations: The intake for the North and South Auxiliary Water Supply (AWS) systems, the south bay of the Entrance (fixed weirs), the North Entrance (sluice gates) and the

approach channel to the entrances. The general layout of the B Branch system and the locations where measurements took place are provided in Figure 1 of this report.

The forebay ranged from 75.2' to 75.4', the tailwater ranged from 12.3' to 13.5' and the entrance head ranged from 1.4' to 1.7' during the testing period. Diffusers FG 5-30 and FG-5-29 were open in the north (entrance) AWS conduit and diffusers FG4-26, 27, & 28 were open on the south (ladder) AWS conduit. Typically FG4-25 would also be open at this tailrace, but the gate is broken.

Project data during the total testing period has ranges for 75.2-75.4 feet for the forebay and 13.1 – 13.5 for the tailrace. It was noted that the pressure transducers need to be recalibrated in some locations. There was some difficulty getting consistent sounding tape readings from the stillwell of the approach channel. The following differences (direct measurement versus simultaneous readings reported from the control room) were recorded:

<u>Location</u>	<u>Difference (Measured-Project data)</u>
Entrance Tailrace	+ 0.02' to + 0.16' $\pm$ 0.05'
Entrance Approach channel	- 0.14' to + 0.53' $\pm$ 0.05'

The project data is provided to the nearest 0.1 feet, whereas the measured data to the nearest 0.01' (if using the same stillwell). Hence the $\pm$ 0.05' is included with the recorded differences.

Fishladder Flow

Bonneville A and B Branch share a common ladder exit. The flow in the upper common section of the ladder was not directly measured this trip. Measurements have been taken during A Branch tests for both 1.0' and 1.3' head on the picketed lead. The flow rates are 212 cfs and 262 cfs respectively. It is assumed there is an equal distribution of flow between the A and B Branches. The head on the picketed lead during this test was 1.2' so the flow from the upper section of the ladder is about 243 cfs—of which 122 cfs goes to B Branch.

Entrance Approach Channel

The location the flow was measured in the approach channel at the downstream edge of the last diffuser and upstream of the fishladder entrances. Measuring at this location should encompass the total flow in the fishladder, which equals the total combined discharge from the entrances. This is considered the most accurate flow measurement taken due to the well-developed flow pattern and

relatively slow velocity. The total discharge at this location was 978 cfs. The average entrance head was 1.61 feet.

Individual Fishway Entrance Measurements

The south bay of the Entrance consists of two sluice gates: SG 4N and SG 4S. SG 4N was open and SG 4S was closed during this test. The flow in the South Entrance was 518 cfs. The average entrance head was 1.66 feet.

The north bay of the Entrance consists of a main fixed weir directed to the west (downstream in the tailrace) and a side fixed weir to spill bay #23. The flow in the main fixed weir was 464 cfs. The average entrance head was 1.55 feet.

The side weir Entrance has been permanently closed at the beginning of this year.

Assuming continuity and assuming approach channel measurement is more reliable, and the North and South Entrance measurements were a combined 4 cfs (0.4 %) high. Some error of the high could come from the sluice gate measurements, where the price meter was pulled into the middle of the opening despite having a 70 lb fish weight attached.

AWS Intake

The AWS intake was sampled at two bulkhead slots just upstream of the trashracks feeding the North and South AWS channels. Measurements at this location would not provide the flow distribution between the North and South AWS branches, but will provide the overall flow through the AWS system. The measurements were taken with an Acoustic Doppler Velocimeter (ADV) mounted on a lead fish and lowered into the slot. A rod was attached to the fish to keep the fish oriented perpendicular to the slot. A total flow of 789 cfs was measured in the AWS system. The average forebay level was 75.27 feet and the gate openings for FV4-3 and FV4-4 were 0.3 and 3.7 feet, respectively.

The methodology for flow measurements were improved compared to previous tests using a pygmy price meter. For this test, an acoustic doppler velocimeter (adv) was inserted into a pre-drilled hole in 75 lb lead fish. The adv was suspended from above into the flow using a standard price meter reel and bridgeboard. Jacob MacDonald devised the latest improvement: the addition of a string interconnected aluminum rods or guiding rod. The guiding rod ran adjacent to the reel cord and was rigidly connected to the adv unit at the bottom. The rod string was restricted from rotation in the horizontal plane and was used to orient the adv directly into the flow so that the x-axis represented the velocity normal to the cross-sectional plane of flow measurement.

Sean Askelson utilized the 3-Dimensional adv data to compare the computed flows rates from the x component versus the total velocity. The total velocities represent what would have been measured by a pygmy meter without the guiding rods, as in previous tests. The comparison showed that the total velocity measurement would overestimate the AWS intake flow by 12%. This percentage can be applied as a correction factor to the previous B Branch AWS measurements.

In the future the guiding rod string can be employed for either adv or price meter. One drawback is that it is rather time consuming and labor intensive. However, Jacob plans to streamline this technique.

Discharge Calculations:

The total flow through the various sampling transects is determined by first calculating an integrated average velocity across the channel at each depth and then integrating the resultant averages again over all depths. The edge of the flow field was extrapolated linearly from the two outermost measurements at a given depth. If the extrapolated value at a channel edge would be greater than the two measure values used to extrapolate it that velocity would be set to the adjacent measurement. The total integrated average velocity was then multiplied by the total cross-sectional area to get a total flow rate.

Conclusions

The table below lists a summary of the measurements taken during this test. (The detailed data sheets are included in the Appendix at the end of this report.) The difference between the total measured system inflows (AWS and ladder flows) and total measured system outflows (Entrance Approach channel flow) is about -68 cfs, or -7% difference. The error is higher than desired limits and may be attributed to fluctuations in the boundary conditions (Forebay & Tailrace) and measurement error. Most likely, there may be some error in the entrance approach channel measurement, since the flow is measurement is located at the end of the diffuser #30 and there will be vertical components of flow in the transition. Overall, this test represents a good test and provides essential data for the application to the computer program.

Conditions during this site visit will be used as input into the HELCRABS B Branch Fishway model. Results from the model run will then be compared to the actual flows measured in order to determine whether deficiencies exist in the model and/or calibrate certain coefficients.

Table 1. Summary of Flow Measurements for B Branch Fishway, 7/2/2003

Bonneville B Branch Fishway: Summary Flow Measurements, 7/2/2003					
Flow Exiting System (cfs)			Flow Entering System (cfs)		
Location	Flow (cfs)		Location	Flow (cfs)	
Entrance Approach Channel	978		AWS North Slot	269	
Sluice Gate	518		AWS South Slot	520	
Main Fixed Weir	464		subtotal AWS	789	
Side Weir (permanently closed)	0				
difference (SG+MFW -EAC)	4		Fishladder Flow	122 (est) ²	
% difference =	0%				
TOTAL ENTRANCE DISCHARGE 978 cfs			TOTAL INFLOW 911 cfs		
Difference (inflow - Outflow) = -68 cfs					
% Difference = -7%					
Comp. of normal velocity to total vel. in AWS meas.					
Vx = Velocity component normal to measuring plane					
Vt = Total Velocity Magnitude = sqrt(Vx ² +Vy ² +Vz ²)					
Qx = Flow passing cross-section = A * Vx (correct discharge)					
Qpm = Flow computation replicating Price meter measurement = Vt * A					
AWS slot	North	South	Total		
Vx	0.69	1.33	1.01		
Vt	0.93	1.35	1.14		
Qx	269	520	789		
Qpm	365	530	894		
Ratio for correction to be applied to previous North AWS slot meas.					
= Qx/Qpm = 88% % reduction = (Qt-Qx)/(Qt) = 12%					
Start Time	8:40	² ladder flow interpolated from previous			
End Time	12:50	measurements			
Min FB	75.20 ft	for Head = 1.0': Qladder =		212 cfs	
Max FB	75.35 ft	and Head =1.3': Qladder =		259 cfs	
Min TW	13.08 ft	Head in this measurement = 1.2'		243 cfs	
Max TW	13.49 ft	Qladder / 2 =		122 cfs	
Min Entrance Head	1.36 ft				
Max Entrance Head	1.73 ft				
weir 67 crest length	42 ft				
Head on ladder control Weir 67	1.20 ft				

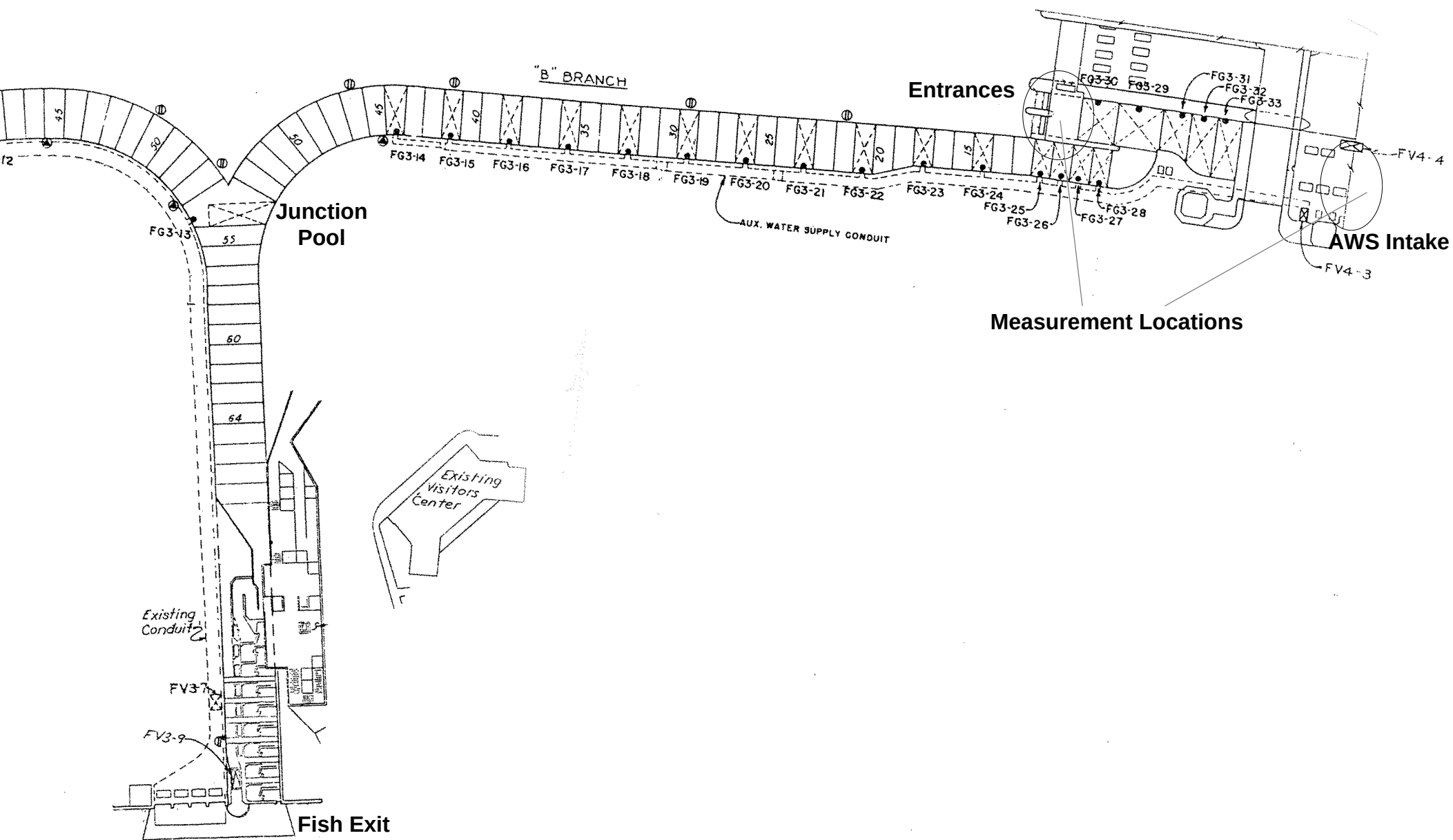


Figure 1
Bradfor Island B Branch
Measurement Locations
July 2, 2003

Velocity Cross-Section of Auxiliary Water
Supply Intake North Slot Looking Downstream
Velocities in ft./sec.

Deck Elevation +85.0

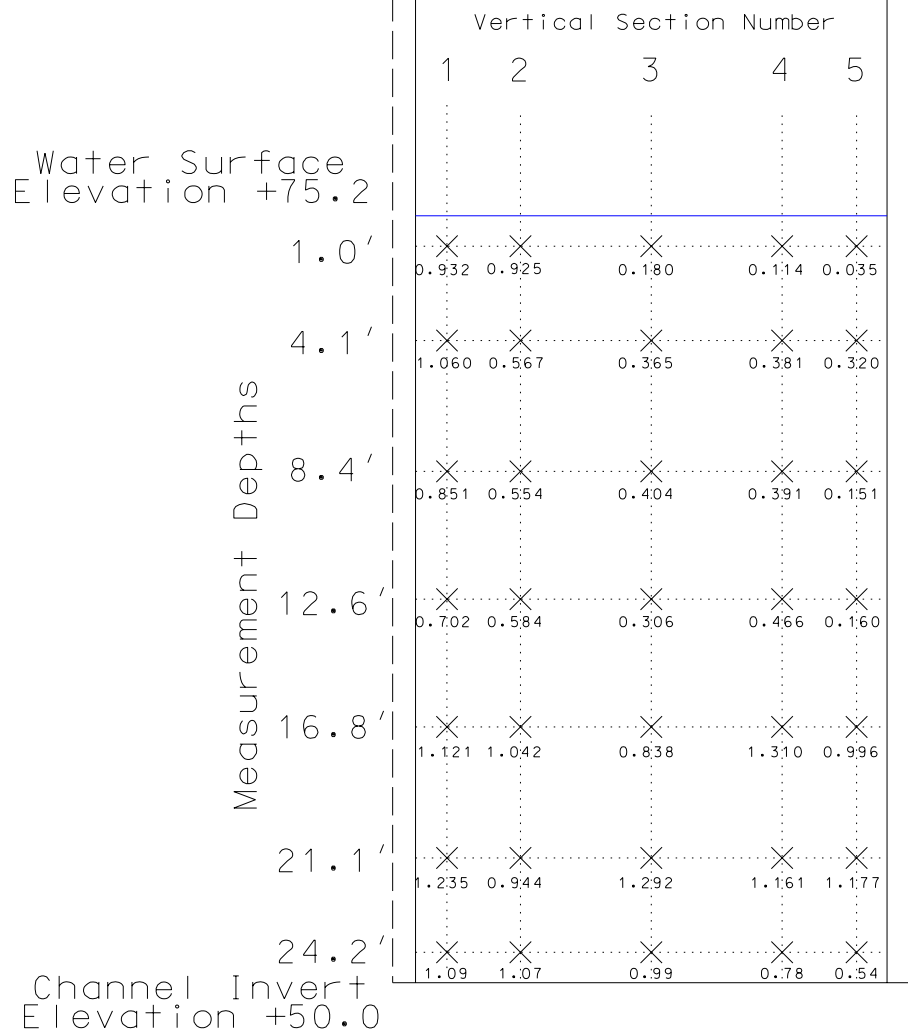


Figure 2
Bradford Island B Branch
Example Velocity Cross-Section
July 2, 2003

AWS INTAKE BULKHEAD SLOT MEASUREMENTS
NORTH SLOT 1

Data Collectors:

JM

LR

TEST NAME:

NORTH AWS SLOT

TEST 1

Date:

7/2/2003

Time:

START

END

11:30

12:50

AWS Intake Tainter Gate Data

Forebay Level =

75.2

75.35

Tailrace Level =

Distance to WS d/s of gate (ft)

60.6

Head d/s of Gate:

24.4

FG4-3

Opening (ft)

0.30

FG4-4

3.80

North

South

1

2

Intake Number from East

AWS INTAKE BULKHEAD SLOT

(Indicate with 'X')

INSTRUMENT

ADV

X

Ident.

Price Meter

 $V = 0.03 + 2.27548 * (\text{rotations/time})$

Price Meter Rotations per Count =

slot

POINT VELOCITY AND FLOW MEASUREMENTS IN AWS:

 Z_{15} = Meas. Distance to WS

9.80

ft (from 85 deck)

WS = Water Surface Elev

75.20

ft (= 85 - Z_{15})

Y = Measured Depth =

25.20

ft (=WS - 60)

B = Channel Width =

15.5

17

0.75

Deck elev =

85.0

Zi = INVERT =

50.0

X1 = Side Edge width inc=

2

Y1 = Vertical edge height incr =

2

weighting factor

0.50

Approx internal dimension =

4.2 ft

Div

Number of Internal X Increments =

3.0

6

Number of Internal Y Increments =

5.0

10

AWS INTAKE MEASUREMENTS

Time:

11:30

12:50

North Bulkhead Slot									
(measured from west side of slot)									
Horiz. No.:	Formula for Depth from Surface (ft)	Depth from Surface (ft)	Vert. Sect. No. :	1	2	3	4	5	Average Integrated Velocity
			Distance From Left Edge (ft)	1.0	4.2	8.5	12.8	16.0	
				1.0	4.2	8.5	12.8	16.0	
1	0.5 * Y1	1.00	Counts	0.932	0.925	0.180	-0.114	-0.035	0.46 ft/s
			duration	n11.vu	n12.vu	n13.vu	n14.vu	n15.vu	
			VELOCITY	0.932	0.925	0.180	0.114	0.035	
2	Y1 + (Y-2*Y1) * 0.1	4.10	Counts	1.060	0.567	0.365	0.381	0.320	0.53 ft/s
			duration	n21.vu	n22.vu	n23.vu	n24.vu	n25.vu	
			VELOCITY	1.060	0.567	0.365	0.381	0.320	
3	Y1 + (Y-2*Y1) * 0.3	8.40	Counts	0.851	0.554	0.404	0.391	0.151	0.49 ft/s
			duration	n31.vu	n32.vu	n33.vu	n34.vu	n35.vu	
			VELOCITY	0.851	0.554	0.404	0.391	0.151	
4	Y/2	12.60	Counts	0.702	0.584	0.306	0.466	-0.160	0.47 ft/s
			duration	n41.vu	n42.vu	n43.vu	n44.vu	n45.vu	
			VELOCITY	0.702	0.584	0.306	0.466	0.160	
5	Y1 + (Y-2*Y1) * 0.7	16.8	Counts	1.121	1.042	0.838	1.310	0.996	1.06 ft/s
			duration	n51.vu	n52.vu	n53.vu	n54.vu	n55.vu	
			VELOCITY	1.121	1.042	0.838	1.310	0.996	
6	Y1 + (Y-2*Y1) * 0.9	21.1	Counts	1.235	0.944	1.292	1.161	1.177	1.16 ft/s
			duration	n61.vu	n62.vu	n63.vu	n64.vu	n65.vu	
			VELOCITY	1.235	0.944	1.292	1.161	1.177	
7	Y - 0.5 * Y1	24.2	Counts	1.085	1.070	0.990	0.781	0.536	0.94 ft/s
			duration	n71.vu	n72.vu	n73.vu	n74.vu	n75.vu	
			VELOCITY	1.09	1.07	0.99	0.78	0.54	
Fish Oreintation									
Total Average Integrated Velocity =				0.71 ft/s					
Total Computed AWS FLOW RATE =				278 cfs (= B * Y * V)					
NOTE:									

BONNEVILLE BRADFORD ISLAND "B" BRANCH FISHWAY VELOCITY DATA

AWS INTAKE BULKHEAD SLOT MEASUREMENTS

SOUTH SLOT 1

Data Collectors: JM LR

TEST NAME: SOUTH SLOT AWS

TEST 1

Date: 7/2/2003

Time: START 8:10 END 10:45

AWS Intake Tainter Gate Data

Forebay Level = 75.3

FG4-3
Opening (ft) 0.30
Distance to WS d/s of gate (ft) 60.9
Head d/s of Gate: 24.1

FG4-4
3.70
30.4
54.6

Tailrace Level =

North South
1 2

Intake Number from East
AWS INTAKE BULKHEAD SLOT
(Indicate with 'X')

INSTRUMENT ADV X
Ident:

Price Meter
 $V = 0.03 + 2.27548 * (\text{rotations/time})$

Price Meter Rotations per Count =

slot

POINT VELOCITY AND FLOW MEASUREMENTS IN AWS:

Z₁₅ = Meas. Distance to WS 9.74 ft (from 85 deck)
WS = Water Surface Elev 75.26 ft (= 85 - Z₁₅)
Y = Measured Depth = 25.26 ft (=WS - 50)

B = Channel Width = 17.0 ft
Deck elev = 85.0 ft
Zi = INVERT = 50.0 ft

X1 = Side Edge width incr = 2
Y1 = Vertical edge height incr = 2
weighting factor 0.50

Approx internal dimension = 4.2 ft
Number of Internal X Increments = 3.0
Number of Internal Y Increments = 5.0
Div 6 10

17
0

AWS INTAKE MEASUREMENTS					Time:		8:10	10:45		
North Bulkhead Slot (measured from west side of slot)										
Horiz. No.:	Formula for Depth from Surface (ft)	Depth from Surface (ft) Column 1	Depth from Surface (ft) Columns 2-5	Vert. Sect. No. : Distance From Left Edge (ft)	1	2	3	4	5	Average Integrated Velocity
					1.0	4.2	8.5	12.8	16.0	
					1.0	4.2	8.5	12.8	16.0	
1	0.5 * Y1	1.0	1.0	Count						ft/s
				File	s11	s72	s13	s14	s15	
				VELOCITY	1.44	1.42	1.51	1.46	0.30	
2	Y1 + (Y-2*Y1) * 0.1	3.1	4.1	Count						ft/s
				File	s21	s22	s23	s24	s25	
				VELOCITY	1.45	1.38	1.45	1.40	0.48	
3	Y1 + (Y-2*Y1) * 0.3	5.4	8.4	Count						ft/s
				File	s31	s32	s33	s34	s35	
				VELOCITY	1.37	1.52	1.42	1.39	1.20	
4	Y/2	7.6	12.6	Count						ft/s
				duration	s41	s42	s43	s44	s45	
				VELOCITY	1.41	1.36	1.41	1.21	0.16	
5	Y1 + (Y-2*Y1) * 0.7	9.9	16.9	Count						ft/s
				File	s51	s52	s53	s54	s55	
				VELOCITY	1.43	1.56	1.39	1.26	0.29	
6	Y1 + (Y-2*Y1) * 0.9	12.1	21.1	Count						ft/s
				File	s61	s62	s63	s64	s65	
				VELOCITY	1.42	1.66	1.46	1.44	1.08	
7	Y - 0.5 * Y1	14.3	24.3	Count						ft/s
				File	s71	s12	s73	s74	s75	
				VELOCITY	1.35	1.59	1.37	1.38	0.92	
8		21.1		Count						ft/s
				File	s81					
				VELOCITY	1.55					
9		24.3		Count						ft/s
				File	s91					
				VELOCITY	1.29					
Total Average Integrated Velocity =					1.29 ft/s					
Total Computed AWS FLOW RATE =					555 cfs (= B * Y * V)					

BONNEVILLE BRADFORD ISLAND "B" BRANCH FISHWAY VELOCITY DAT/

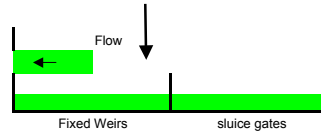
ENTRANCE CHANNEL MEASUREMENTS
Large Approach Channel to Entrances

Data Collectors: PW SA SJS

TEST 1

Date: 7/2/2003

Time: 10:15 11:50



	Distance to Water:			WATER LEVEL ELEV:		
	start	end	Ref EL	start	end	
Tailrace Level :	44.89	44.62	58.11	13.22	13.49	
U/s Channel:	43.60	43.31	58.42	14.82	15.11	
Entrance Heads:			1.60	1.62		

Sluice Gate Data	
SG 4N	SG 4S
X if Open (if used)	X

Fixed Weir Data	
Main	Side
X if Open (if used)	X

INSTRUMENT

Price Meter X

Price Meter Rotations per Count = 1
V=0.0178+2.2048 * (rotations/time)

NORTH AWS DIFFUSERS OPEN:				
30	29	31	32	33
			X	X

SOUTH AWS DIFFUSERS OPEN:									
14	15	16	17	18	19				
20	21	22	23	24	25	26	27	28	
						X	X	X	

POINT VELOCITY AND FLOW MEASUREMENTS IN ENTRANCE APPROACH CHANNEL:

WS = Water Surface Elevation =
Y = Measured AWS Channel Depth =
Edge Effort Weighting Factor =

14.84	ft (Same as U/S Cha above)
12.84	ft (=WS - 2)
0.5	

B = Channel Width = 35.0 ft
BRIDGE INVERT ELEV. = 60.0 ft
Z1 = AWS INVERT = 2.0 ft

X1 = Side Edge width incr =
Y1 = Vertical edge height incr =

3
2

Aprox internal dimension = 4.5 ft
Number of Internal X Increments = 6.0
Number of Internal Y Increments = 3.0

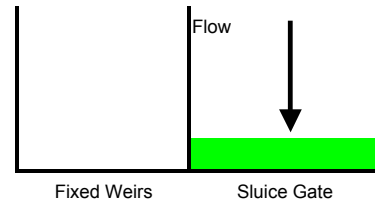
Horiz. No.:	Formula for Distance from surface	Depth from Surface (ft)	Ver Sec	1	2	3	4	5	6	7	8	Average Integrated Velocity
			Distance From Left Edge (ft)	1.5	5.4	10.3	15.1	19.9	24.8	29.6	33.5	
				1.5	5.4	10.3	15.1	19.9	24.8	29.6	33.5	
1	0.5*Y1	1.5	Counts	66	47	56	52	59	66	78	61	
			duration	60	60	60	60	60	60	60	60	
			VELOCITY	2.44	1.74	2.08	1.93	2.19	2.44	2.88	2.26	2.24 ft/s
2	Y1 + (Y-2*Y1)/6	4.1	Counts	50	37	38	36	59	59	69	50	
			duration	60	60	60	60	60	60	60	60	
			VELOCITY	1.86	1.38	1.41	1.34	2.19	2.19	2.55	1.86	1.84 ft/s
3	Y/2	6.4	Counts	55	52	45	42	56	56	65	46	
			duration	60	60	60	60	60	60	60	60	
			VELOCITY	2.04	1.93	1.67	1.56	2.08	2.08	2.41	1.71	1.93 ft/s
4	Y1 + 5* (Y-2*Y1)/6	8.7	Counts	51	66	80	72	57	57	64	65	
			duration	60	60	60	60	60	60	60	60	
			VELOCITY	1.89	2.44	2.96	2.66	2.11	2.11	2.37	2.41	2.38 ft/s
5	Y - 0.5 * Y1	11.3	Counts	48	71	60	64	75	84	65	55	
			duration	60	60	60	60	60	60	60	60	
			VELOCITY	1.78	2.63	2.22	2.37	2.77	3.10	2.41	2.04	2.45 ft/s
Total Average Integrated Velocity =			2.18 ft/s									
Total Computed Entrance Channel FLOW RATE =			981 cfs (= B * Y * V)									

BONNEVILLE BRADFORD ISLAND "B" BRANCH FISHWAY VELOCITY DATA
ENTRANCE CHANNEL MEASUREMENTS
South Channel to Sluice Gates

Data Collectors: PW SA SJS

TEST 1

Date: 7/2/2003 Time: Start 8:55 End 10:00



	Distance to Water:			WATER LEVEL ELEV:		
	start	end	Ref EL	start	end	
Tailrace Level :	45.03	44.89	58.11	13.08	13.22	
U/s Staff Gage :	43.61	43.60	58.42	14.81	14.82	
Entrance Heads:				1.73	1.60	

Sluice Gate Data	
SG 4N	SG 4S
Open? X	

INSTRUMENT

Price Meter X

 Price Meter Rotations per Count = 1
 $V = 0.0178 + 2.2048 * (\text{rotations/time})$
POINT VELOCITY AND FLOW MEASUREMENTS IN ENTRANCE:

Z ₁₅ = Meas. Distance to AWS WS =	41.34	ft (from 56 bridge)	B = Channel Width =	15.0	ft
WS = Water Surface Elevation =	14.66	ft (= 56 - Z ₁₅)	BRIDGE ELEV. =	56.0	ft
Y = Measured AWS Channel Depth =	12.66	ft (= WS - 2)	Zi = AWS INVERT =	2.0	ft
Edge Effort Weighting Factor =	0.5				

 X1 = Side Edge width inc= 2
 Y1 = Vertical edge height incr = 3

 Appox internal dimension = 4.0 ft Div
 Number of Internal X Increments = 3.0 6
 Number of Internal Y Increments = 2.0 4

Horiz. No.:	Formula for Distance from surface	Depth from Surface (ft)	Vert. Sect. No. :	1	2	3	4	5	Average Integrated Velocity
			Distance From Left Edge (ft)	1.0	3.8	7.5	11.2	14.0	
				1.0	3.8	7.5	11.2	14.0	
1	0.5*Y1	1.5	Counts	12	33	42	48	39	
			duration	45	45	45	45	45	
			VELOCITY	0.61	1.63	2.08	2.37	1.93	1.77 ft/s
2	Y1 + (Y-2*Y1)/6	4.1	Counts	28	37	45	57	51	
			duration	45	45	45	45	45	
			VELOCITY	1.39	1.83	2.22	2.81	2.52	2.17 ft/s
3	Y/2	6.3	Counts	33	33	49	57	59	
			duration	45	45	45	45	45	
			VELOCITY	1.63	1.63	2.42	2.81	2.91	2.29 ft/s
4	Y1 + 5* (Y-2*Y1)/6	8.6	Counts	43	36	52	130	143	
			duration	60	45	45	45	45	
			VELOCITY	1.60	1.78	2.57	6.39	7.02	3.79 ft/s
5	Y - 0.5 * Y1	11.2	Counts	22	30	49	175	155	
			duration	45	45	45	45	45	
			VELOCITY	1.10	1.49	2.42	8.59	7.61	4.17 ft/s
Total Average Integrated Velocity =				2.86 ft/s					
Total Computed Channel FLOW RATE =				543 cfs (= B * Y * V)					

NOTES:

BONNEVILLE BRADFORD ISLAND "B" BRANCH FISHWAY VELOCITY DATA
ENTRANCE CHANNEL MEASUREMENTS
North Channel to Fixed Weirs

 Data Collectors:

PW	SA	SJS
----	----	-----

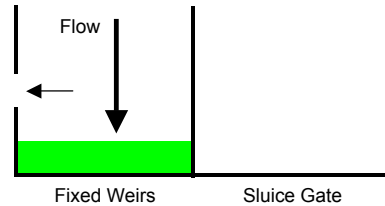
TEST 1

 Date:

7/2/2003

 Time:

Start	End
7:40	8:45



	Distance to Water:			WATER LEVEL ELEV:	
	start	end	Ref EL	start	end
Tailrace Level :	44.85	45.03	58.11	13.26	13.08
U/s Staff Gage :	start	end	Ref EL	start	end
	43.80	43.61	58.42	14.62	14.81
Entrance Heads:				1.36	1.73

Sluice Gate Data	
SG 4N	SG 4S
Main	Side
Open?	X

 INSTRUMENT Price Meter

X

 Price Meter Rotations per Count =

1

 $V = 0.0178 + 2.2048 * (\text{rotations/time})$
POINT VELOCITY AND FLOW MEASUREMENTS IN ENTRANCE:

Z₁₅ = Meas. Distance to AWS WS =	<table border="1"><tr><td>41.50</td></tr></table> ft (from 56 bridge)	41.50	B = Channel Width =	<table border="1"><tr><td>15.0</td></tr></table> ft	15.0
41.50					
15.0					
WS = Water Surface Elevation =	<table border="1"><tr><td>14.50</td></tr></table> ft (= 56 - Z ₁₅)	14.50	BRIDGE ELEV. =	<table border="1"><tr><td>56.0</td></tr></table> ft	56.0
14.50					
56.0					
Y = Measured AWS Channel Depth =	<table border="1"><tr><td>12.50</td></tr></table> ft (=WS - 2)	12.50	Zi = AWS INVERT =	<table border="1"><tr><td>2.0</td></tr></table> ft	2.0
12.50					
2.0					
Edge Effort Weighting Factor =	<table border="1"><tr><td>0.5</td></tr></table>	0.5			
0.5					

 X1 = Side Edge width inc=

2

 Y1 = Vertical edge height incr =

3

 Approx internal dimension = 4.0 ft Div
 Number of Internal X Increments = 3.0 6
 Number of Internal Y Increments = 2.0 4

Horiz. No.:	Formula for Distance from surface	Depth from Surface (ft)	Vert. Sect. No. :	1	2	3	4	5	Average Integrated Velocity
			Distance From Left Edge (ft)	1.0	3.8	7.5	11.2	14.0	
				1.5	3.8	7.5	11.2	14.0	
1	0.5*Y1	1.5	Counts	54	61	61	54	43	
			duration	45	45	45	45	45	
			VELOCITY	2.66	3.01	3.01	2.66	2.12	2.73 ft/s
2	Y1 + (Y-2*Y1)/6	4.1	Counts	56	65	67	52	40	
			duration	45	45	45	45	45	
			VELOCITY	2.76	3.20	3.30	2.57	1.98	2.81 ft/s
3	Y/2	6.3	Counts	56	61	60	42	33	
			duration	45	45	45	45	45	
			VELOCITY	2.76	3.01	2.96	2.08	1.63	2.53 ft/s
4	Y1 + 5* (Y-2*Y1)/6	8.4	Counts	52	53	56	43	32	
			duration	45	45	45	45	45	
			VELOCITY	2.57	2.61	2.76	2.12	1.59	2.37 ft/s
5	Y - 0.5 * Y1	11.0	Counts	45	48	49	36	24	
			duration	45	45	45	45	45	
			VELOCITY	2.22	2.37	2.42	1.78	1.19	2.04 ft/s
Total Average Integrated Velocity =				2.48 ft/s					
Total Computed Channel FLOW RATE =				465 cfs (= B * Y * V)					

NOTES:

BONNEVILLE B BRANCH FISHWAY VELOCITY DATA**FV3-9 Intake (Ladder Augmentation flow)**

Data Collectors:

SJS

Date: 7/2/2003 Time:

start	end
	17:00

FV3-9 Tainter Gate Data

Forebay Level =

start	end
	75.80

Head on Picketed Lead =

start	end
	1.20

Opening (ft)

start	end
	0.90

 US Valve_9.2
 Distance to WS d/s of gate (ft)

start	end
	18.25

 DS Valve_16.8
 Head d/s of Gate:

start	end
	68.25

INSTRUMENT

Price Meter

Price Meter Rotations per Count =

$$V = 0.03 + 2.27548 * (\text{rotations/time})$$

POINT VELOCITY AND FLOW MEASUREMENTS:**Z₁₅ = Meas. Distance to AWS WS =**

ft (from 85 level)

B = Channel Width = 9.50 ft

WS = Water Surface Elevation =

85.00 ft (= 85 - Z₁₅)**Grating ELEVATION = 85.0** ft**Y = Measured AWS Channel Depth =**

22.00 ft (=WS - 63)

Zi = INVERT = 63.0 ft

X1 = Side Edge width incr = 2 ft
 Y1 = Vertical edge height incr = 2 ft

Approx internal dimension =

3.0 ft

Div by

Number of Internal X Increments =

2.0

4

Number of Internal Y Increments =

3.0

6

Horiz. No.:	Formula for depthn below surface (pm)	Depth from Surface (ft)	Vert. Sect. No. :	1	2	3	4	Average Velocity
			Est Dist. from Left Edge (ft)	1.0	3.50	6.50	8.00	
			Actual Dist (ft) from Fft side	1.00	3.50	5.75	9.17	
1	0.5 * Y1		Counts					
			duration					
			VELOCITY					ft/s
2	Y1 + (Y-2*Y1)/6		Counts					
			duration					
			VELOCITY					ft/s
3	Y/2		Counts					
			duration					
			VELOCITY					ft/s
4	Y1 + 5* (Y-2*Y1)/6		Counts					
			duration					
			VELOCITY					ft/s
5	Y - 0.5*Y1		Counts					
			duration					
			VELOCITY					ft/s
Total Average Integrated Velocity =				ft/s				
Total Computed FLOW RATE =				cfs				(= B * Y * V)

Appendix C

Model Output For Data Collection Conditions

Model Output for Data Collection Conditions

This appendix contains output files for the operations and conditions encountered during the data collection for the model calibration. As described in the main body the data collection was taken under two operational settings over two separate days. The .TXT File is the output of the closed conduit program and the .PRN is the output from the open channel program. The Table below provides relevant information for each of these model runs.

File Name	Date	Forebay (ft NVGD)	Tailrace (ft NVGD)
110702.TXT	7 Nov 2002	75.2	11.52
110702.PRN	7 Nov 2002	75.2	11.52
070203.TXT	2 Jul 2003	73.9	13.2
070203.PRN	2 Jul 2003	73.9	13.2

Appendix B of this report provides the actual measurements taken during the data collection as well as the operations and conditions for each data set.

FLOWRATE IS EXPRESSED IN CFS AND PRESSURE IN PSIG

A SUMMARY OF THE ORIGINAL DATA FOLLOWS

THE DARCY WEISBACH HEAD LOSS EQUATION IS USED, THE KINEMATIC VIS. = .0000100

PIPE NO.	NODE NOS.	LENGTH (FEET)	DIAMETER (INCHES)	ROUGHNESS	MINOR LOSS K	FIXED GRADE
1	0 1	85.0	180.0	4.0	.60	73.90
2	1 2	4.0	87.8	4.0	16.93	
3	2 3	36.0	114.9	4.0	1.50	
4	3 4	90.0	114.9	4.0	.07	
5	4 0	3.0	40.7	4.0	1.50	1000.00
LINE 5	IS CLOSED					
6	4 5	18.0	114.9	4.0	.10	
7	5 0	3.0	40.7	4.0	1.50	1000.00
LINE 7	IS CLOSED					
8	5 6	16.0	114.9	4.0	.10	
9	6 0	3.0	40.7	4.0	1.50	1000.00
LINE 9	IS CLOSED					
10	6 7	35.0	81.3	4.0	.10	
11	7 0	13.0	40.7	4.0	1.50	13.01
12	7 8	33.8	81.2	4.0	.10	
13	8 0	13.0	40.7	4.0	1.50	13.01
14	1 12	6.0	87.8	4.0	26.16	
15	12 13	24.0	114.9	4.0	2.12	
16	13 14	70.0	114.9	4.0	1.16	
17	14 15	15.0	114.9	4.0	2.12	
18	15 16	60.0	114.9	4.0	.00	
19	16 280	24.8	76.6	4.0	.00	
20	280 0	1.0	40.7	4.0	2.50	13.36
21	16 17	16.0	114.9	4.0	.10	
22	17 270	23.8	76.6	4.0	.00	
23	270 0	1.0	40.7	4.0	2.50	13.54
24	17 18	16.0	114.9	4.0	.10	
25	18 260	22.8	76.6	4.0	.00	
26	260 0	1.0	40.7	4.0	2.50	1000.00
LINE 26	IS CLOSED					
27	18 19	16.0	114.9	4.0	.10	
28	19 250	21.8	76.6	4.0	.00	
29	250 0	1.0	40.7	4.0	2.50	1000.00
LINE 29	IS CLOSED					
30	19 20	48.0	114.9	4.0	.10	
31	20 240	19.0	76.6	4.0	.00	
32	240 0	1.0	40.7	4.0	2.50	1000.00
LINE 32	IS CLOSED					
33	20 21	48.0	114.9	4.0	.10	
34	21 230	18.0	76.6	4.0	.00	
35	230 0	1.0	40.7	4.0	2.50	1000.00
LINE 35	IS CLOSED					
36	21 22	48.0	114.9	4.0	.10	
37	22 220	17.0	76.6	4.0	.00	
38	220 0	1.0	40.7	4.0	2.50	1000.00
LINE 38	IS CLOSED					

110702.txt							
	39	22	23	48.0	114.9	4.0	.10
	40	23	210	16.0	76.6	4.0	.00
	41	210	0	1.0	40.7	4.0	2.50
LINE	41	IS CLOSED					
	42	23	24	24.0	94.8	4.0	.10
	43	24	25	24.0	94.8	4.0	.00
	44	25	200	15.0	71.7	4.0	.00
	45	200	0	1.0	40.7	4.0	2.50
LINE	45	IS CLOSED					
	46	25	26	48.0	94.8	4.0	.10
	47	26	190	14.0	71.7	4.0	.00
	48	190	0	1.0	40.7	4.0	2.50
LINE	48	IS CLOSED					
	49	26	27	24.0	81.2	4.0	.10
	50	27	28	24.0	81.2	4.0	.00
	51	28	180	13.0	60.6	4.0	.00
	52	180	0	1.0	40.7	4.0	2.50
LINE	52	IS CLOSED					
	53	28	29	48.0	81.2	4.0	.10
	54	29	170	12.0	60.6	4.0	.00
	55	170	0	1.0	40.7	4.0	2.50
LINE	55	IS CLOSED					
	56	29	30	24.0	67.7	4.0	.10
	57	30	31	24.0	67.7	4.0	.00
	58	31	160	11.0	54.2	4.0	.00
	59	160	0	1.0	40.7	4.0	2.50
LINE	59	IS CLOSED					
	60	31	32	48.0	67.7	4.0	.10
	61	32	150	10.0	54.2	4.0	.00
	62	150	0	1.0	40.7	4.0	2.50
LINE	62	IS CLOSED					
	63	32	33	24.0	54.2	4.0	.10
	64	33	34	24.0	54.2	4.0	.00
	65	34	140	9.0	54.2	4.0	.80
	66	140	0	1.2	40.7	4.0	2.50
LINE	66	IS CLOSED					
	67	16	0	1.0	36.0	4.0	.10
LINE	67	IS CLOSED					

JUNCTION	NUMBER	DEMAND	ELEVATION	CONNECTING PIPES		
	1	.00	.00	1	2	14
	2	.00	.00	2	3	
	3	.00	.00	3	4	
	4	.00	.00	4	5	6
	5	.00	.00	6	7	8
	6	.00	.00	8	9	10
	7	.00	.00	10	11	12
	8	.00	.00	12	13	
	12	.00	.00	14	15	
	13	.00	.00	15	16	
	14	.00	.00	16	17	
	15	.00	.00	17	18	
	16	.00	.00	18	19	21
	17	.00	.00	21	22	24
	18	.00	.00	24	25	27
	19	.00	.00	27	28	30
	20	.00	.00	30	31	33
	21	.00	.00	33	34	36
	22	.00	.00	36	37	39
	23	.00	.00	39	40	42
	24	.00	.00	42	43	
	25	.00	.00	43	44	46

110702.txt

26	.00	.00	46	47	49
27	.00	.00	49	50	
28	.00	.00	50	51	53
29	.00	.00	53	54	56
30	.00	.00	56	57	
31	.00	.00	57	58	60
32	.00	.00	60	61	63
33	.00	.00	63	64	
34	.00	.00	64	65	
140	.00	.00	65	66	
150	.00	.00	61	62	
160	.00	.00	58	59	
170	.00	.00	54	55	
180	.00	.00	51	52	
190	.00	.00	47	48	
200	.00	.00	44	45	
210	.00	.00	40	41	
220	.00	.00	37	38	
230	.00	.00	34	35	
240	.00	.00	31	32	
250	.00	.00	28	29	
260	.00	.00	25	26	
270	.00	.00	22	23	
280	.00	.00	19	20	

OUTPUT SELECTION: ALL RESULTS ARE OUTPUT EACH PERIOD

THIS SYSTEM HAS 67 PIPES WITH 46 JUNCTIONS , 0 LOOPS AND 22 FGNS

THE RESULTS ARE OBTAINED AFTER 5 TRIALS WITH AN ACCURACY = .00015

BONNEVILLE DAM B- BRANCH FISHWAY
AWS ANALYSIS

PIPE	NO.	NODE	NOS.	FLOWRATE	HEAD LOSS	PUMP	HEAD	MINOR LOSS	VELOCITY	HL/1000
1	0	1		914.63	.03	.00		.25	5.18	.41
2	1	2		509.92	.02	.00		38.74	12.14	5.36
3	2	3		509.92	.05	.00		1.17	7.08	1.32
4	3	4		509.92	.12	.00		.05	7.08	1.32
LINE	5	IS	CLOSED							
6	4	5		509.92	.02	.00		.08	7.08	1.32
LINE	7	IS	CLOSED							
8	5	6		509.92	.02	.00		.08	7.08	1.32
LINE	9	IS	CLOSED							
10	6	7		509.92	.28	.00		.31	14.13	7.96
11	7	0		255.43	.98	.00		18.69	28.33	75.36
12	7	8		254.49	.07	.00		.08	7.07	2.00
13	8	0		254.49	.97	.00		18.55	28.22	74.81
14	1	12		404.71	.02	.00		37.72	9.64	3.38
15	12	13		404.71	.02	.00		1.04	5.62	.83
16	13	14		404.71	.06	.00		.57	5.62	.83
17	14	15		404.71	.01	.00		1.04	5.62	.83
18	15	16		404.71	.05	.00		.00	5.62	.83
19	16	280		202.85	.04	.00		.00	6.34	1.73
20	280	0		202.85	.05	.00		19.64	22.49	47.56
21	16	17		201.86	.00	.00		.01	2.80	.21

				110702.txt				
22	17	270	201.86	.04	.00	.00	6.31	1.72
23	270	0	201.86	.05	.00	19.45	22.38	47.09
24	17	18	.00	.00	.00	.00	.00	.00
25	18	260	.00	.00	.00	.00	.00	.00
LINE 26	IS	CLOSED						
27	18	19	.00	.00	.00	.00	.00	.00
28	19	250	.00	.00	.00	.00	.00	.00
LINE 29	IS	CLOSED						
30	19	20	.00	.00	.00	.00	.00	.00
31	20	240	.00	.00	.00	.00	.00	.00
LINE 32	IS	CLOSED						
33	20	21	.00	.00	.00	.00	.00	.00
34	21	230	.00	.00	.00	.00	.00	.00
LINE 35	IS	CLOSED						
36	21	22	.00	.00	.00	.00	.00	.00
37	22	220	.00	.00	.00	.00	.00	.00
LINE 38	IS	CLOSED						
39	22	23	.00	.00	.00	.00	.00	.00
40	23	210	.00	.00	.00	.00	.00	.00
LINE 41	IS	CLOSED						
42	23	24	.00	.00	.00	.00	.00	.00
43	24	25	.00	.00	.00	.00	.00	.00
44	25	200	.00	.00	.00	.00	.00	.00
LINE 45	IS	CLOSED						
46	25	26	.00	.00	.00	.00	.00	.00
47	26	190	.00	.00	.00	.00	.00	.00
LINE 48	IS	CLOSED						
49	26	27	.00	.00	.00	.00	.00	.00
50	27	28	.00	.00	.00	.00	.00	.00
51	28	180	.00	.00	.00	.00	.00	.00
LINE 52	IS	CLOSED						
53	28	29	.00	.00	.00	.00	.00	.00
54	29	170	.00	.00	.00	.00	.00	.00
LINE 55	IS	CLOSED						
56	29	30	.00	.00	.00	.00	.00	.00
57	30	31	.00	.00	.00	.00	.00	.00
58	31	160	.00	.00	.00	.00	.00	.00
LINE 59	IS	CLOSED						
60	31	32	.00	.00	.00	.00	.00	.00
61	32	150	.00	.00	.00	.00	.00	.00
LINE 62	IS	CLOSED						
63	32	33	.00	.00	.00	.00	.00	.00
64	33	34	.00	.00	.00	.00	.00	.00
65	34	140	.00	.00	.00	.00	.00	.00
LINE 66	IS	CLOSED						
LINE 67	IS	CLOSED						

JUNCTION	NUMBER	DEMAND	GRADE	LINE	ELEVATION	PRESSURE
	1	.00	73.62			
	2	.00	34.85			
	3	.00	33.64			
	4	.00	33.46			
	5	.00	33.36			
	6	.00	33.26			
	7	.00	32.67			
	8	.00	32.53			
	12	.00	35.88			
	13	.00	34.82			
	14	.00	34.19			
	15	.00	33.14			
	16	.00	33.09			
	17	.00	33.08			

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18	.00	33.08
19	.00	33.08
20	.00	33.08
21	.00	33.08
22	.00	33.08
23	.00	33.08
24	.00	33.08
25	.00	33.08
26	.00	33.08
27	.00	33.08
28	.00	33.08
29	.00	33.08
30	.00	33.08
31	.00	33.08
32	.00	33.08
33	.00	33.08
34	.00	33.08
140	.00	33.08
150	.00	33.08
160	.00	33.08
170	.00	33.08
180	.00	33.08
190	.00	33.08
200	.00	33.08
210	.00	33.08
220	.00	33.08
230	.00	33.08
240	.00	33.08
250	.00	33.08
260	.00	33.08
270	.00	33.03
280	.00	33.05

THE NET SYSTEM DEMAND = .00

SUMMARY OF INFLOWS(+) AND OUTFLOWS(-) FROM FIXED GRADE NODES

PIPE NUMBER	FLOWRATE
1	914.63
11	-255.43
13	-254.49
20	-202.85
23	-201.86

THE NET FLOW INTO THE SYSTEM FROM FIXED GRADE NODES = 914.63
 THE NET FLOW OUT OF THE SYSTEM INTO FIXED GRADE NODES = -914.63

Fish Passage Program version 1.5

Input File:fish.inp

Output File:fish.out

BONNEVILLE B branch

Tailwater: 11.52

Head @ Top Weir: 1.00

Fish Ladder Discharge: 192.13

Weir Component: 147.17

Orifice Component: 44.96

Weir no.	Weir Width	Crest Len	Crest Elev	W.S. Elev	Q	Weir Q	Orifice Q	h0	h1	h2	Weir Vel	Weir Coef
Collection Channel				13.01								
8	30.00	10.40	8.00	13.36	500.77	473.63	26.53	0.35	5.36	5.01	3.90	4.50
Ladder Diffuser 28 Discharge:					202.85	vel:	0.70					
9	30.00	10.40	9.00	13.54	297.92	279.46	19.00	0.18	4.54	4.36	2.88	4.50
Ladder Diffuser 27 Discharge:					201.86	vel:	0.70					
10	30.00	10.40	10.00	13.57	96.06	86.74	8.07	0.03	3.57	3.54	1.28	4.50
Ladder Diffuser 26 Discharge:					0.00	vel:	0.00					
11	30.00	10.40	11.00	13.66	96.06	82.44	13.54	0.09	2.66	2.57	2.03	4.50
Ladder Diffuser 25 Discharge:					0.00	vel:	0.00					
12	30.00	10.40	12.00	13.98	96.06	70.67	25.47	0.32	1.98	1.66	3.43	4.50
13	30.00	10.40	13.00	14.40	96.06	73.08	29.16	0.42	1.40	0.98	5.01	4.50
14	30.00	10.40	14.00	15.15	96.06	57.40	38.74	0.74	1.15	0.40	4.82	4.50
Ladder Diffuser 24 Discharge:					0.00	vel:	0.00					
15	30.00	10.40	15.00	16.08	96.06	52.55	43.44	0.93	1.08	0.15	4.68	4.50
16	30.00	10.40	16.00	17.07	96.06	51.48	44.61	0.99	1.07	0.08	4.65	4.50
17	30.00	10.40	17.00	18.06	96.06	51.27	44.87	1.00	1.06	0.07	4.64	4.50
Ladder Diffuser 23 Discharge:					0.00	vel:	0.00					
18	30.00	10.40	18.00	19.06	96.06	51.20	44.92	1.00	1.06	0.06	4.64	4.50
19	35.00	10.40	19.00	20.06	96.06	51.13	44.92	1.00	1.06	0.06	4.63	4.50
20	40.00	10.40	20.00	21.06	96.06	51.06	44.92	1.00	1.06	0.06	4.63	4.50
Ladder Diffuser 22 Discharge:					0.00	vel:	0.00					
21	40.00	10.40	21.00	22.06	96.06	51.08	44.95	1.00	1.06	0.06	4.63	4.50
22	40.00	10.40	22.00	23.06	96.06	51.11	44.95	1.00	1.06	0.06	4.63	4.50
23	40.00	10.40	23.00	24.06	96.06	51.18	44.96	1.00	1.06	0.06	4.64	4.50
Ladder Diffuser 21 Discharge:					0.00	vel:	0.00					

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24	40.00	10.40	24.00	25.06	96.06	51.11	44.92	1.00	1.06	0.06	4.63	4.50
25	40.00	10.40	25.00	26.06	96.06	51.17	44.96	1.00	1.06	0.06	4.64	4.50
26	40.00	10.40	26.00	27.06	96.06	51.10	44.92	1.00	1.06	0.06	4.63	4.50
Ladder Diffuser 20 Discharge: 0.00 vel: 0.00												
27	40.00	10.40	27.00	28.06	96.06	51.16	44.96	1.00	1.06	0.06	4.64	4.50
28	40.00	10.40	28.00	29.06	96.06	51.09	44.92	1.00	1.06	0.06	4.63	4.50
29	40.00	10.40	29.00	30.06	96.06	51.14	44.96	1.00	1.06	0.06	4.64	4.50
Ladder Diffuser 19 Discharge: 0.00 vel: 0.00												
30	40.00	10.40	30.00	31.06	96.06	51.07	44.92	1.00	1.06	0.06	4.63	4.50
31	40.00	10.40	31.00	32.06	96.06	51.10	44.95	1.00	1.06	0.06	4.63	4.50
32	40.00	10.40	32.00	33.06	96.06	51.15	44.96	1.00	1.06	0.06	4.64	4.50
Ladder Diffuser 18 Discharge: 0.00 vel: 0.00												
33	40.00	10.40	33.00	34.06	96.06	51.08	44.92	1.00	1.06	0.06	4.63	4.50
34	40.00	10.40	34.00	35.06	96.06	51.11	44.95	1.00	1.06	0.06	4.63	4.50
35	40.00	10.40	35.00	36.06	96.06	51.18	44.96	1.00	1.06	0.06	4.64	4.50
Ladder Diffuser 17 Discharge: 0.00 vel: 0.00												
36	40.00	10.40	36.00	37.06	96.06	51.11	44.92	1.00	1.06	0.06	4.63	4.50
37	40.00	10.40	37.00	38.06	96.06	51.18	44.96	1.00	1.06	0.06	4.64	4.50
38	40.00	10.40	38.00	39.06	96.06	51.11	44.92	1.00	1.06	0.06	4.63	4.50
Ladder Diffuser 16 Discharge: 0.00 vel: 0.00												
39	40.00	10.40	39.00	40.06	96.06	51.18	44.96	1.00	1.06	0.06	4.64	4.50
40	40.00	10.40	40.00	41.06	96.06	51.11	44.92	1.00	1.06	0.06	4.63	4.50
41	40.00	10.40	41.00	42.06	96.06	51.18	44.96	1.00	1.06	0.06	4.64	4.50
Ladder Diffuser 15 Discharge: 0.00 vel: 0.00												
42	40.00	10.40	42.00	43.06	96.06	51.11	44.92	1.00	1.06	0.06	4.63	4.50
43	40.00	10.40	43.00	44.06	96.06	51.18	44.96	1.00	1.06	0.06	4.64	4.50
44	40.00	10.40	44.00	45.06	96.06	51.11	44.92	1.00	1.06	0.06	4.63	4.50
Ladder Diffuser 14 Discharge: 0.00 vel: 0.00												
45	40.00	10.40	45.00	46.06	96.06	51.18	44.96	1.00	1.06	0.06	4.64	4.50
46	40.00	10.40	46.00	47.06	96.06	51.11	44.92	1.00	1.06	0.06	4.63	4.50
47	40.00	10.40	47.00	48.06	96.06	51.18	44.96	1.00	1.06	0.06	4.64	4.50
48	40.00	10.40	48.00	49.06	96.06	51.11	44.92	1.00	1.06	0.06	4.63	4.50
49	40.00	10.40	49.00	50.06	96.06	51.18	44.96	1.00	1.06	0.06	4.64	4.50
50	40.00	10.40	50.00	51.06	96.06	51.11	44.92	1.00	1.06	0.06	4.63	4.50
51	40.00	10.40	51.00	52.06	96.06	51.18	44.96	1.00	1.06	0.06	4.64	4.50
52	40.00	10.40	52.00	53.06	96.06	51.11	44.92	1.00	1.06	0.06	4.63	4.50
53	40.00	10.40	53.00	54.06	96.06	51.18	44.96	1.00	1.06	0.06	4.64	4.50
54	57.00	57.00	54.00	54.84	192.13	152.48	39.55	0.77	0.84	0.06	3.20	3.50
55	47.00	47.00	55.00	55.92	192.13	145.37	46.81	1.08	0.92	-0.16	3.36	3.50
56	42.00	42.00	56.00	56.99	192.13	145.50	46.54	1.07	0.99	-0.08	3.49	3.50
57	42.00	42.00	57.00	58.00	192.13	147.22	45.12	1.01	1.00	-0.01	3.50	3.50
58	42.00	42.00	58.00	59.00	192.13	147.00	44.92	1.00	1.00	0.00	3.50	3.50
59	42.00	42.00	59.00	60.00	192.13	147.22	44.96	1.00	1.00	0.00	3.50	3.50
60	42.00	42.00	60.00	61.00	192.13	147.00	44.92	1.00	1.00	0.00	3.50	3.50
61	42.00	42.00	61.00	62.00	192.13	147.22	44.96	1.00	1.00	0.00	3.50	3.50
62	42.00	42.00	62.00	63.00	192.13	147.00	44.92	1.00	1.00	0.00	3.50	3.50
63	42.00	42.00	63.00	64.00	192.13	147.22	44.96	1.00	1.00	0.00	3.50	3.50
64	42.00	42.00	64.00	65.00	192.13	147.00	44.92	1.00	1.00	0.00	3.50	3.50

65 42.00 42.00 65.00 66.00 192.13 147.22 44.96 1.00 1.00 0.00 3.50 3.50

Channel Head above tailwater: 1.49

---Entrance---		---PCC Diffuser---		-----PCC-----			
Gate No.	Discharge (cfs)	No.	Discharge (cfs)	Velocity (fps)	Discharge (cfs)	Velocity (fps)	Elev (ft)
		31	0.00	0.00	500.77	1.30	13.01
		32	0.00	0.00	500.77	1.30	13.01
		33	0.00	0.00	500.77	1.30	13.01
		29	255.44	0.89	500.77	1.30	13.01
		30	254.49	0.88	756.21	1.96	13.01
4	249.55				1010.70	2.62	13.01
Weir Elev: 6.00 ft					761.15	1.98	13.01
3	342.60				418.54	1.09	13.01
Weir Elev: 6.00 ft					418.54	1.09	13.01
2	0.00						
Gate Opening: 0.00 ft							
1	422.54						
Gate Opening: 12.50 ft					-3.99	-0.01	13.01

□

Summary Table

				Tailwater Elevation: 11.52	
				Channel Head: 1.49	
Inflows		Q	V	Outflows	
-----				-----	
Fish Ladder	Discharge	:	192.13	A Branch	Fish Ladder: 96.06
Ladder	Diffuser	27:	201.86		Entrance 4: 249.55
Ladder	Diffuser	28:	202.85		Entrance 3: 342.60
	PCC Diffuser	29:	255.44		Entrance 2: 0.00
	PCC Diffuser	30:	254.49		Entrance 1: 422.54

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Total Inflow: 1106.76

Total Outflow: 1110.76
surplus Outflow: 3.99

JUNCTION NUMBER DEMAND
THE NET SYSTEM DEMAND = .00

SUMMARY OF INFLOWS(+) AND OUTFLOWS(-) FROM FIXED GRADE NODES

PIPE NUMBER	FLOWRATE	GRADE
1	914.63	73.90
11	-255.43	13.01
13	-254.49	13.01
20	-202.85	13.36
23	-201.86	13.54

THE NET FLOW INTO THE SYSTEM FROM FIXED GRADE NODES = 914.63
THE NET FLOW OUT OF THE SYSTEM INTO FIXED GRADE NODES = -914.63
premature end of file

FLOWRATE IS EXPRESSED IN CFS AND PRESSURE IN PSIG

A SUMMARY OF THE ORIGINAL DATA FOLLOWS

THE DARCY WEISBACH HEAD LOSS EQUATION IS USED, THE KINEMATIC VIS. = .0000100

PIPE NO.	NODE NOS.	LENGTH (FEET)	DIAMETER (INCHES)	ROUGHNESS	MINOR LOSS K	FIXED GRADE
1	0 1	85.0	180.0	4.0	.60	75.30
2	1 2	4.0	87.8	4.0	4.02	
3	2 3	36.0	114.9	4.0	1.90	
4	3 4	90.0	114.9	4.0	.07	
5	4 0	3.0	40.7	4.0	1.50	1000.00
LINE 5	IS CLOSED					
6	4 5	18.0	114.9	4.0	.10	
7	5 0	3.0	40.7	4.0	1.50	1000.00
LINE 7	IS CLOSED					
8	5 6	16.0	114.9	4.0	.10	
9	6 0	3.0	40.7	4.0	1.50	1000.00
LINE 9	IS CLOSED					
10	6 7	35.0	81.3	4.0	.10	
11	7 0	13.0	40.7	4.0	1.50	14.66
12	7 8	33.8	81.2	4.0	.10	
13	8 0	13.0	40.7	4.0	1.50	14.66
14	1 12	6.0	87.8	4.0	504.32	
15	12 13	24.0	114.9	4.0	2.12	
16	13 14	70.0	114.9	4.0	1.16	
17	14 15	15.0	114.9	4.0	2.12	
18	15 16	60.0	114.9	4.0	.00	
19	16 280	24.8	76.6	4.0	.00	
20	280 0	1.0	40.7	4.0	2.50	14.70
21	16 17	16.0	114.9	4.0	.10	
22	17 270	23.8	76.6	4.0	.00	
23	270 0	1.0	40.7	4.0	2.50	14.74
24	17 18	16.0	114.9	4.0	.10	
25	18 260	22.8	76.6	4.0	.00	
26	260 0	1.0	40.7	4.0	2.50	14.78
27	18 19	16.0	114.9	4.0	.10	
28	19 250	21.8	76.6	4.0	.00	
29	250 0	1.0	40.7	4.0	2.50	1000.00
LINE 29	IS CLOSED					
30	19 20	48.0	114.9	4.0	.10	
31	20 240	19.0	76.6	4.0	.00	
32	240 0	1.0	40.7	4.0	2.50	1000.00
LINE 32	IS CLOSED					
33	20 21	48.0	114.9	4.0	.10	
34	21 230	18.0	76.6	4.0	.00	
35	230 0	1.0	40.7	4.0	2.50	1000.00
LINE 35	IS CLOSED					
36	21 22	48.0	114.9	4.0	.10	
37	22 220	17.0	76.6	4.0	.00	
38	220 0	1.0	40.7	4.0	2.50	1000.00
LINE 38	IS CLOSED					
39	22 23	48.0	114.9	4.0	.10	

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40	23	210	16.0	76.6	4.0	.00	
41	210	0	1.0	40.7	4.0	2.50	1000.00
LINE 41	IS CLOSED						
42	23	24	24.0	94.8	4.0	.10	
43	24	25	24.0	94.8	4.0	.00	
44	25	200	15.0	71.7	4.0	.00	
45	200	0	1.0	40.7	4.0	2.50	1000.00
LINE 45	IS CLOSED						
46	25	26	48.0	94.8	4.0	.10	
47	26	190	14.0	71.7	4.0	.00	
48	190	0	1.0	40.7	4.0	2.50	1000.00
LINE 48	IS CLOSED						
49	26	27	24.0	81.2	4.0	.10	
50	27	28	24.0	81.2	4.0	.00	
51	28	180	13.0	60.6	4.0	.00	
52	180	0	1.0	40.7	4.0	2.50	1000.00
LINE 52	IS CLOSED						
53	28	29	48.0	81.2	4.0	.10	
54	29	170	12.0	60.6	4.0	.00	
55	170	0	1.0	40.7	4.0	2.50	1000.00
LINE 55	IS CLOSED						
56	29	30	24.0	67.7	4.0	.10	
57	30	31	24.0	67.7	4.0	.00	
58	31	160	11.0	54.2	4.0	.00	
59	160	0	1.0	40.7	4.0	2.50	1000.00
LINE 59	IS CLOSED						
60	31	32	48.0	67.7	4.0	.10	
61	32	150	10.0	54.2	4.0	.00	
62	150	0	1.0	40.7	4.0	2.50	1000.00
LINE 62	IS CLOSED						
63	32	33	24.0	54.2	4.0	.10	
64	33	34	24.0	54.2	4.0	.00	
65	34	140	9.0	54.2	4.0	.80	
66	140	0	1.2	40.7	4.0	2.50	1000.00
LINE 66	IS CLOSED						
67	16	0	1.0	36.0	4.0	.10	31.10
LINE 67	IS CLOSED						

JUNCTION	NUMBER	DEMAND	ELEVATION	CONNECTING	PIPES	
1	.00	.00	1	2	14	
2	.00	.00	2	3		
3	.00	.00	3	4		
4	.00	.00	4	5	6	
5	.00	.00	6	7	8	
6	.00	.00	8	9	10	
7	.00	.00	10	11	12	
8	.00	.00	12	13		
12	.00	.00	14	15		
13	.00	.00	15	16		
14	.00	.00	16	17		
15	.00	.00	17	18		
16	.00	.00	18	19	21	67
17	.00	.00	21	22	24	
18	.00	.00	24	25	27	
19	.00	.00	27	28	30	
20	.00	.00	30	31	33	
21	.00	.00	33	34	36	
22	.00	.00	36	37	39	
23	.00	.00	39	40	42	
24	.00	.00	42	43		
25	.00	.00	43	44	46	
26	.00	.00	46	47	49	

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27	.00	.00	49	50	
28	.00	.00	50	51	53
29	.00	.00	53	54	56
30	.00	.00	56	57	
31	.00	.00	57	58	60
32	.00	.00	60	61	63
33	.00	.00	63	64	
34	.00	.00	64	65	
140	.00	.00	65	66	
150	.00	.00	61	62	
160	.00	.00	58	59	
170	.00	.00	54	55	
180	.00	.00	51	52	
190	.00	.00	47	48	
200	.00	.00	44	45	
210	.00	.00	40	41	
220	.00	.00	37	38	
230	.00	.00	34	35	
240	.00	.00	31	32	
250	.00	.00	28	29	
260	.00	.00	25	26	
270	.00	.00	22	23	
280	.00	.00	19	20	

OUTPUT SELECTION: ALL RESULTS ARE OUTPUT EACH PERIOD

THIS SYSTEM HAS 67 PIPES WITH 46 JUNCTIONS , 0 LOOPS AND 22 FGNS

THE RESULTS ARE OBTAINED AFTER 6 TRIALS WITH AN ACCURACY = .00004

BONNEVILLE DAM B- BRANCH FISHWAY
AWS ANALYSIS

PIPE	NO.	NODE NOS.	FLOWRATE	HEAD LOSS	PUMP HEAD	MINOR LOSS	VELOCITY	HL/1000
1	0	1	823.31	.03	.00	.20	4.66	.33
2	1	2	707.65	.04	.00	17.71	16.85	10.31
3	2	3	707.65	.09	.00	2.85	9.83	2.53
4	3	4	707.65	.23	.00	.10	9.83	2.53
LINE 5	IS	CLOSED						
6	4	5	707.65	.05	.00	.15	9.83	2.53
LINE 7	IS	CLOSED						
8	5	6	707.65	.04	.00	.15	9.83	2.53
LINE 9	IS	CLOSED						
10	6	7	707.65	.54	.00	.60	19.61	15.32
11	7	0	354.48	1.89	.00	35.99	39.31	145.06
12	7	8	353.17	.13	.00	.15	9.81	3.85
13	8	0	353.17	1.87	.00	35.72	39.16	143.99
14	1	12	115.67	.00	.00	59.39	2.75	.28
15	12	13	115.67	.00	.00	.08	1.61	.07
16	13	14	115.67	.00	.00	.05	1.61	.07
17	14	15	115.67	.00	.00	.08	1.61	.07
18	15	16	115.67	.00	.00	.00	1.61	.07
19	16	280	39.66	.00	.00	.00	1.24	.07
20	280	0	39.66	.00	.00	.75	4.40	1.83
21	16	17	76.01	.00	.00	.00	1.06	.03
22	17	270	38.56	.00	.00	.00	1.20	.06

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23	270	0	38.56	.00	.00	.71	4.28	1.73
24	17	18	37.45	.00	.00	.00	.52	.01
25	18	260	37.45	.00	.00	.00	1.17	.06
26	260	0	37.45	.00	.00	.67	4.15	1.64
27	18	19	.00	.00	.00	.00	.00	.00
28	19	250	.00	.00	.00	.00	.00	.00
LINE 29	IS	CLOSED						
30	19	20	.00	.00	.00	.00	.00	.00
31	20	240	.00	.00	.00	.00	.00	.00
LINE 32	IS	CLOSED						
33	20	21	.00	.00	.00	.00	.00	.00
34	21	230	.00	.00	.00	.00	.00	.00
LINE 35	IS	CLOSED						
36	21	22	.00	.00	.00	.00	.00	.00
37	22	220	.00	.00	.00	.00	.00	.00
LINE 38	IS	CLOSED						
39	22	23	.00	.00	.00	.00	.00	.00
40	23	210	.00	.00	.00	.00	.00	.00
LINE 41	IS	CLOSED						
42	23	24	.00	.00	.00	.00	.00	.00
43	24	25	.00	.00	.00	.00	.00	.00
44	25	200	.00	.00	.00	.00	.00	.00
LINE 45	IS	CLOSED						
46	25	26	.00	.00	.00	.00	.00	.00
47	26	190	.00	.00	.00	.00	.00	.00
LINE 48	IS	CLOSED						
49	26	27	.00	.00	.00	.00	.00	.00
50	27	28	.00	.00	.00	.00	.00	.00
51	28	180	.00	.00	.00	.00	.00	.00
LINE 52	IS	CLOSED						
53	28	29	.00	.00	.00	.00	.00	.00
54	29	170	.00	.00	.00	.00	.00	.00
LINE 55	IS	CLOSED						
56	29	30	.00	.00	.00	.00	.00	.00
57	30	31	.00	.00	.00	.00	.00	.00
58	31	160	.00	.00	.00	.00	.00	.00
LINE 59	IS	CLOSED						
60	31	32	.00	.00	.00	.00	.00	.00
61	32	150	.00	.00	.00	.00	.00	.00
LINE 62	IS	CLOSED						
63	32	33	.00	.00	.00	.00	.00	.00
64	33	34	.00	.00	.00	.00	.00	.00
65	34	140	.00	.00	.00	.00	.00	.00
LINE 66	IS	CLOSED						
LINE 67	IS	CLOSED						

JUNCTION	NUMBER	DEMAND	GRADE	LINE	ELEVATION	PRESSURE
	1	.00	75.07			
	2	.00	57.32			
	3	.00	54.38			
	4	.00	54.05			
	5	.00	53.85			
	6	.00	53.66			
	7	.00	52.53			
	8	.00	52.25			
	12	.00	15.68			
	13	.00	15.60			
	14	.00	15.54			
	15	.00	15.46			
	16	.00	15.45			
	17	.00	15.45			
	18	.00	15.45			

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19	.00	15.45
20	.00	15.45
21	.00	15.45
22	.00	15.45
23	.00	15.45
24	.00	15.45
25	.00	15.45
26	.00	15.45
27	.00	15.45
28	.00	15.45
29	.00	15.45
30	.00	15.45
31	.00	15.45
32	.00	15.45
33	.00	15.45
34	.00	15.45
140	.00	15.45
150	.00	15.45
160	.00	15.45
170	.00	15.45
180	.00	15.45
190	.00	15.45
200	.00	15.45
210	.00	15.45
220	.00	15.45
230	.00	15.45
240	.00	15.45
250	.00	15.45
260	.00	15.45
270	.00	15.45
280	.00	15.45

THE NET SYSTEM DEMAND = .00

SUMMARY OF INFLOWS(+) AND OUTFLOWS(-) FROM FIXED GRADE NODES

PIPE NUMBER	FLOWRATE
1	823.31
11	-354.48
13	-353.17
20	-39.66
23	-38.56
26	-37.45

THE NET FLOW INTO THE SYSTEM FROM FIXED GRADE NODES = 823.31
 THE NET FLOW OUT OF THE SYSTEM INTO FIXED GRADE NODES = -823.31

Fish Passage Program version 1.5

Input File:fish.inp

Output File:fish.out

BONNEVILLE B branch

Tailwater: 13.20
 Head @ Top Weir: 1.20

Fish Ladder Discharge: 238.26
 Weir Component: 189.36
 Orifice Component: 48.90

Weir no.	Weir Width	Crest Len	Crest Elev	W.S. Elev	Q	Weir Q	Orifice Q	h0	h1	h2	Weir Vel	Weir Coef
Collection Channel				14.66								
8	30.00	10.40	8.00	14.70	234.80	226.50	8.77	0.04	6.70	6.66	1.40	4.50
Ladder Diffuser 28 Discharge:					39.65	Vel:	0.14					
9	30.00	10.40	9.00	14.74	195.16	185.84	8.77	0.04	5.74	5.70	1.40	4.50
Ladder Diffuser 27 Discharge:					38.57	Vel:	0.13					
10	30.00	10.40	10.00	14.78	156.59	148.86	8.99	0.04	4.78	4.74	1.43	4.50
Ladder Diffuser 26 Discharge:					37.46	Vel:	0.13					
11	30.00	10.40	11.00	14.82	119.13	109.83	9.21	0.04	3.82	3.78	1.45	4.50
Ladder Diffuser 25 Discharge:					0.00	Vel:	0.00					
12	30.00	10.40	12.00	14.93	119.13	105.19	14.39	0.10	2.93	2.82	2.17	4.50
13	30.00	10.40	13.00	15.25	119.13	93.55	25.63	0.33	2.25	1.93	3.30	4.50
14	30.00	10.40	14.00	15.79	119.13	105.10	32.91	0.54	1.79	1.25	5.65	4.50
Ladder Diffuser 24 Discharge:					0.00	Vel:	0.00					
15	30.00	10.40	15.00	16.47	119.13	82.05	37.13	0.68	1.47	0.79	5.37	4.50
16	30.00	10.40	16.00	17.38	119.13	76.10	42.94	0.91	1.38	0.47	5.29	4.50
17	30.00	10.40	17.00	18.36	119.13	74.57	44.52	0.98	1.36	0.38	5.26	4.50
Ladder Diffuser 23 Discharge:					0.00	Vel:	0.00					
18	30.00	10.40	18.00	19.36	119.13	74.33	44.87	1.00	1.36	0.36	5.25	4.50
19	35.00	10.40	19.00	20.36	119.13	74.25	44.92	1.00	1.36	0.36	5.25	4.50
20	40.00	10.40	20.00	21.36	119.13	74.17	44.92	1.00	1.36	0.36	5.25	4.50
Ladder Diffuser 22 Discharge:					0.00	Vel:	0.00					
21	40.00	10.40	21.00	22.36	119.13	74.25	44.96	1.00	1.36	0.36	5.25	4.50
22	40.00	10.40	22.00	23.36	119.13	74.17	44.92	1.00	1.36	0.36	5.25	4.50
23	40.00	10.40	23.00	24.36	119.13	74.24	44.96	1.00	1.36	0.36	5.25	4.50
Ladder Diffuser 21 Discharge:					0.00	Vel:	0.00					

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24	40.00	10.40	24.00	25.36	119.13	74.16	44.92	1.00	1.36	0.36	5.25	4.50
25	40.00	10.40	25.00	26.36	119.13	74.23	44.96	1.00	1.36	0.36	5.25	4.50
26	40.00	10.40	26.00	27.36	119.13	74.15	44.92	1.00	1.36	0.36	5.25	4.50
Ladder Diffuser 20 Discharge: 0.00 vel: 0.00												
27	40.00	10.40	27.00	28.36	119.13	74.20	44.96	1.00	1.36	0.36	5.25	4.50
28	40.00	10.40	28.00	29.36	119.13	74.12	44.92	1.00	1.36	0.36	5.25	4.50
29	40.00	10.40	29.00	30.36	119.13	74.15	44.95	1.00	1.36	0.36	5.25	4.50
Ladder Diffuser 19 Discharge: 0.00 vel: 0.00												
30	40.00	10.40	30.00	31.36	119.13	74.21	44.96	1.00	1.36	0.36	5.25	4.50
31	40.00	10.40	31.00	32.36	119.13	74.13	44.92	1.00	1.36	0.36	5.25	4.50
32	40.00	10.40	32.00	33.36	119.13	74.17	44.95	1.00	1.36	0.36	5.25	4.50
Ladder Diffuser 18 Discharge: 0.00 vel: 0.00												
33	40.00	10.40	33.00	34.36	119.13	74.25	44.96	1.00	1.36	0.36	5.25	4.50
34	40.00	10.40	34.00	35.36	119.13	74.17	44.92	1.00	1.36	0.36	5.25	4.50
35	40.00	10.40	35.00	36.36	119.13	74.25	44.96	1.00	1.36	0.36	5.25	4.50
Ladder Diffuser 17 Discharge: 0.00 vel: 0.00												
36	40.00	10.40	36.00	37.36	119.13	74.17	44.92	1.00	1.36	0.36	5.25	4.50
37	40.00	10.40	37.00	38.36	119.13	74.25	44.96	1.00	1.36	0.36	5.25	4.50
38	40.00	10.40	38.00	39.36	119.13	74.17	44.92	1.00	1.36	0.36	5.25	4.50
Ladder Diffuser 16 Discharge: 0.00 vel: 0.00												
39	40.00	10.40	39.00	40.36	119.13	74.25	44.96	1.00	1.36	0.36	5.25	4.50
40	40.00	10.40	40.00	41.36	119.13	74.17	44.92	1.00	1.36	0.36	5.25	4.50
41	40.00	10.40	41.00	42.36	119.13	74.25	44.96	1.00	1.36	0.36	5.25	4.50
Ladder Diffuser 15 Discharge: 0.00 vel: 0.00												
42	40.00	10.40	42.00	43.36	119.13	74.17	44.92	1.00	1.36	0.36	5.25	4.50
43	40.00	10.40	43.00	44.36	119.13	74.25	44.96	1.00	1.36	0.36	5.25	4.50
44	40.00	10.40	44.00	45.36	119.13	74.17	44.92	1.00	1.36	0.36	5.25	4.50
Ladder Diffuser 14 Discharge: 0.00 vel: 0.00												
45	40.00	10.40	45.00	46.36	119.13	74.25	44.96	1.00	1.36	0.36	5.25	4.50
46	40.00	10.40	46.00	47.36	119.13	74.17	44.92	1.00	1.36	0.36	5.25	4.50
47	40.00	10.40	47.00	48.36	119.13	74.25	44.96	1.00	1.36	0.36	5.25	4.50
48	40.00	10.40	48.00	49.36	119.13	74.17	44.92	1.00	1.36	0.36	5.25	4.50
49	40.00	10.40	49.00	50.36	119.13	74.25	44.96	1.00	1.36	0.36	5.25	4.50
50	40.00	10.40	50.00	51.36	119.13	74.17	44.92	1.00	1.36	0.36	5.25	4.50
51	40.00	10.40	51.00	52.36	119.13	74.25	44.96	1.00	1.36	0.36	5.25	4.50
52	40.00	10.40	52.00	53.36	119.13	74.17	44.92	1.00	1.36	0.36	5.25	4.50
53	40.00	10.40	53.00	54.36	119.13	74.25	44.96	1.00	1.36	0.36	5.25	4.50
54	57.00	57.00	54.00	55.01	238.26	201.84	36.16	0.65	1.01	0.36	3.51	3.50
55	47.00	47.00	55.00	56.10	238.26	190.95	47.06	1.10	1.10	0.01	3.68	3.50
56	42.00	42.00	56.00	57.19	238.26	191.40	46.87	1.09	1.19	0.10	3.82	3.50
57	42.00	42.00	57.00	58.20	238.26	193.28	45.12	1.01	1.20	0.19	3.83	3.50
58	42.00	42.00	58.00	59.20	238.26	193.28	44.94	1.00	1.20	0.20	3.83	3.50
59	42.00	42.00	59.00	60.20	238.26	193.28	44.94	1.00	1.20	0.20	3.83	3.50
60	42.00	42.00	60.00	61.20	238.26	193.28	44.94	1.00	1.20	0.20	3.83	3.50
61	42.00	42.00	61.00	62.20	238.26	193.28	44.94	1.00	1.20	0.20	3.83	3.50
62	42.00	42.00	62.00	63.20	238.26	193.28	44.94	1.00	1.20	0.20	3.83	3.50
63	42.00	42.00	63.00	64.20	238.26	193.28	44.94	1.00	1.20	0.20	3.83	3.50
64	42.00	42.00	64.00	65.20	238.26	193.28	44.94	1.00	1.20	0.20	3.83	3.50

65 42.00 42.00 65.00 66.20 238.26 193.28 44.94 1.00 1.20 0.20 3.83 3.50

Channel Head above tailwater: 1.47

---Entrance---		---PCC Diffuser---		-----PCC-----			
Gate No.	Discharge (cfs)	No.	Discharge (cfs)	Velocity (fps)	Discharge (cfs)	Velocity (fps)	Elev (ft)
		31	0.00	0.00	234.80	0.53	14.66
		32	0.00	0.00	234.80	0.53	14.66
		33	0.00	0.00	234.80	0.53	14.66
		29	354.48	1.23	234.80	0.53	14.66
		30	353.17	1.23	589.28	1.33	14.66
4	0.00				942.45	2.13	14.66
Weir Elev: 6.00 ft					942.45	2.13	14.66
3	452.25				490.21	1.11	14.66
Weir Elev: 6.00 ft					490.21	1.11	14.66
2	0.00				490.21	1.11	14.66
Gate Opening: 0.00 ft					-0.65	0.00	14.66
1	490.86						
Gate Opening: 12.50 ft							

□

Summary Table									
				Tailwater Elevation:		13.20			
				Channel Head:		1.47			
Inflows				Q	V	Outflows			
-----						-----			
Fish Ladder	Discharge	:	238.26			A Branch	Fish Ladder:		119.13
Ladder	Diffuser	26:	37.46	0.13			Entrance 4:		0.00
Ladder	Diffuser	27:	38.57	0.13			Entrance 3:		452.25
Ladder	Diffuser	28:	39.65	0.14			Entrance 2:		0.00
	PCC Diffuser	29:	354.48	1.23			Entrance 1:		490.86
	PCC Diffuser	30:	353.17	1.23					

Total Inflow: 1061.58

Total Outflow: 1062.23

JUNCTION NUMBER DEMAND
THE NET SYSTEM DEMAND = .00

SUMMARY OF INFLOWS(+) AND OUTFLOWS(-) FROM FIXED GRADE NODES

PIPE NUMBER	FLOWRATE	GRADE
1	823.31	75.30
11	-354.48	14.66
13	-353.17	14.66
20	-39.66	14.70
23	-38.56	14.74
26	-37.45	14.78

THE NET FLOW INTO THE SYSTEM FROM FIXED GRADE NODES = 823.31

THE NET FLOW OUT OF THE SYSTEM INTO FIXED GRADE NODES = -823.31

premature end of file

Appendix D

Review Comments

Comment Report: User's Comments

For the **90%** phase of project **HELCRABS-Bradford Island 'B' Branch Adult Fishway**(sorted by Discipline , ID)

Displaying 56 comments.

Id	Discipline	DocType	Spec	Sheet	Detail
597743	Biology/Ecology	Design Analysis	n/a	n/a	n/a
Section 1 page 1 second paragraph.. Which BIOP? 1991? 2000? (Submitted 17-Jun-04 by Larry Beck Larry.M.Beck@nwp01.usace.army.mil (541) 374-8801.)					
1-0	Evaluation Concurred We are acting on the 2000 Biop. I added that to the text you are talking about. (30-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Close Comment Closed without comment. (16-Aug-04 by Larry Beck Larry.M.Beck@nwp01.usace.army.mil (541) 374-8801).				
	Current Comment Status: Comment Closed				
597759	Biology/Ecology	Design Analysis	n/a	n/a	n/a
Page 7 middle bullet--- Are all the openings a total of 10.4 ft. even the last wier at the bottom of the junction Pool? (Submitted 17-Jun-04 by Larry Beck Larry.M.Beck@nwp01.usace.army.mil (541) 374-8801.)					
1-0	Evaluation Concurred Those bullets are describing the weirs downstream of the junction pools (up to weir 53). This is explained in the paragraph preceding the bullets. These are what we were considering the B branch ladder weirs. I added text at the beginning of the existing fishway section to clarify that the shared portion of the two branches (junction pool to exit) are evaluated as part of the A Branch report. (30-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Close Comment Closed without comment. (16-Aug-04 by Larry Beck Larry.M.Beck@nwp01.usace.army.mil (541) 374-8801).				
	Current Comment Status: Comment Closed				
597893	Biology/Ecology	Design Analysis	n/a	n/a	n/a
Page 19. second to last paragraph which starts as "in addition to the criteria".The test in which this 5 PSI was determined is located in Bonneville Dam FishWay Modificatin Plan 20 April,1991. Auxiliary Water conduit Fingerling Salmon Mortality Studies, Bonneville Dam 1952 and 1958-59. Have a biologist review the report to determine how to apply the information to the current criteria.. I would suggest Mike Langeslay as he did the most current study on the how many fish were using these AWS's. (Submitted 17-Jun-04 by Larry Beck Larry.M.Beck@nwp01.usace.army.mil (541) 374-8801. Revised 17-Jun-04.)					
1-0	Evaluation For Information Only As far as I can tell, it is set as an operational criteria in the modifications for peaking report (referenced in same sentence). You make a good point and maybe someone should double check whether that criteria is still relevant but that is outside of the scope of the B Branch evaluation report. The purpose of our current report isn't to re-evaluate criteria that have been established, but to evaluate the fishway with regards to current criteria. (30-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				

1-1	Backcheck Recommendation Close Comment Closed without comment. (16-Aug-04 by Larry Beck Larry.M.Beck@nwp01.usace.army.mil (541) 374-8801).				
	Current Comment Status: Comment Closed				
597907	Biology/Ecology	Design Analysis	n/a	n/a	n/a
Page 22 second paragraph.. How is a negative pressure created or where are these negative pressure located? (Submitted 17-Jun-04 by Larry Beck Larry.M.Beck@nwp01.usace.army.mil (541) 374-8801.)					
1-0	Evaluation For Information Only The negative pressure is better described as a negative head differential that would force flow into the diffuser rather than out of it. This could happen to the further upstream diffusers of the south AWS because they are at higher elevations and because (with the proposed diffuser operations) we would have more diffusers on allowing more flow through the system and more losses in the system. This situation doesn't appear in the model but someone mentioned that it was for this reason that only 7 diffusers are operated at a time under the current operations (of course we can't find the source of that information). The paragraph has been removed and a note made about the potential for this in 5.2. We also recommend monitoring for this if we try the operations proposed in the report. (30-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Close Comment Closed without comment. (16-Aug-04 by Larry Beck Larry.M.Beck@nwp01.usace.army.mil (541) 374-8801).				
	Current Comment Status: Comment Closed				
597921	Biology/Ecology	Design Analysis	n/a	n/a	n/a
page 24 Chart 4.2 ladder head second to last collumum.. I am assuming that this is what I call water over the weir. I noticed that they were changed according to tailwater. Currently we change the water over the wier level when shad are present not at some tailwater level. (Submitted 17-Jun-04 by Larry Beck Larry.M.Beck@nwp01.usace.army.mil (541) 374-8801.)					
1-0	Evaluation Concurred Yes, the ladder head is the head over the weir. For our evaluation we correlated shad passage to the higher tailwaters because the shad passage season is spring where we are more likely to get higher tailwaters. We did this rather than doing two sets of evaluations for all tailwaters (one assuming 1 ft of head and the other 1.3 ft of head). The difference isn't really significant to the overall evaluation. I added a not to the table explaining the switch from 1 to 1.3 ft of head. (30-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Close Comment Closed without comment. (16-Aug-04 by Larry Beck Larry.M.Beck@nwp01.usace.army.mil (541) 374-8801).				
	Current Comment Status: Comment Closed				
597934	Biology/Ecology	Design Analysis	n/a	n/a	n/a
Page 26 third paragraph labeled Picket leads at old fish lock system approach. Check with biologist for criteria that would be needed to address lamprey concerns. (Submitted 17-Jun-04 by Larry Beck Larry.M.Beck@nwp01.usace.army.mil (541) 374-8801. Revised 17-Jun-04.)					
1-0	Evaluation For Information Only This report doesn't really evaluate the ladder performance with respect to species other				

	than those with established criteria. The picketed leads are a recommendation to keep fish out of the fish lock entrance when we have higher flows coming out of the diffuser. If operations chooses to implement this, all issues (including lamprey concerns) would need to be considered at that time. (30-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Close Comment Closed without comment. (16-Aug-04 by Larry Beck Larry.M.Beck@nwp01.usace.army.mil (541) 374-8801).				
	Current Comment Status: Comment Closed				
615948	Biology/Ecology	Design Analysis	n/a	n/a	n/a
1. Computational model developed by NHC. The major deficiencies appear to have been addressed to the point that the output can be effectively used to characterize fishway conditions. Ease of use and utility of output should be improved as outlined in section 5.1. Priority items would be; Remove or change hard constraints to match actual range of conditions that have occurred at Bonneville, as recommended in the report. Make model compatibility with USACE computers, as recommended. Output should contain all input and settings used to create model run, as recommended. Some designation should be provided when model output is out of criteria. Colors were recommended but an added column with a symbol or label would be more printer and copy friendly. Output should be in form easily transferable to spreadsheet. Fixed-length delimited probably most adaptable. (Submitted 06-Jul-04 by Christopher Peery cpeery@uidaho.edu 208 885-7223.)					
1-0	Evaluation Concurred We have put a little effort into a newer GUI and will incorporate your comments into it (printer friendly version and excel output version). (09-Jul-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Close Comment Closed without comment. (11-Aug-04 by Christopher Peery cpeery@uidaho.edu 208 885-7223).				
	Current Comment Status: Comment Closed				
615949	Biology/Ecology	Design Analysis	n/a	n/a	n/a
2. Entrance modifications. My opinion is that priority attention should be placed on modifications that will improve passage conditions in the lower range of elevations as low flow years and seasons will outnumber high flow periods in the future. These were my comments on potential entry modifications; Alternative A (replace sluice gates with modulated weir) appears to provide the best potential results to maintain entrance criteria. The fixed-weir shape option may also be promising but without additional information how a specific design would affect entry conditions I can not address this option. The report did not address how narrowing the main fixed weir entrance by rounding the bulkhead for lamprey affected entrance flow and velocity conditions. A short discussion on this would be useful. (Submitted 06-Jul-04 by Christopher Peery cpeery@uidaho.edu 208 885-7223.)					
1-0	Evaluation Concurred Most of these decisions will need to made after a feasibility phase. The feasibility phase would allow us to look into the details and costs of pursuing any options mentioned in the report. Your recommendations are noted. We mention the addition of half-rounds to the fixed weir entrance in section 2.2.1.1. The impacts are discussed in section 4.3.1 but the closure of the side weir and the addition of the 2 ft spacers to the fixed weir entrance (reducing entrance width) are emphasized over the half rounds for reducing the flow capacity for a given entrance head drop. They all contribute but the side weir closure and the spacers are the more significant contributors. Text added in 4.3.1 to clarify. (09-Jul-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				

1-1	Backcheck Recommendation Close Comment Closed without comment. (11-Aug-04 by Christopher Peery cpeery@uidaho.edu 208 885-7223).				
	Current Comment Status: Comment Closed				
615950	Biology/Ecology	Design Analysis	n/a	n/a	n/a
I believe narrowing the entrance chamber should be explored further. A 30 ft width would match the lower ladder segment and likely not affect fishway capacity. Restrictions, such as those that occur upstream from the junction pool (count window, vertical slots) are more likely to be constrained capacity of the fishway than the entrance. Addition of picket leads to partition the fish locks is recommended. Pickets should be angled or curved to aide guiding fish around the corner into ladder. Pickets may pose a problem to adult lamprey. As such, spacing should either be large enough to allow lamprey to pass in and out easily or small enough to eliminate most lamprey to pass. There has been some discussion on using fish lock area as a collection point for lamprey bypass structure/fishway, in which case this could be designed into the pickets. (Submitted 06-Jul-04 by Christopher Peery cpeery@uidaho.edu 208 885-7223.)					
1-0	Evaluation Concurred That is a good point about the upstream constrictions and is noted. Details of the picket leads will be worked out in the feasibility or design phase (if we get that far). Your comments are noted. (09-Jul-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Close Comment Closed without comment. (11-Aug-04 by Christopher Peery cpeery@uidaho.edu 208 885-7223).				
	Current Comment Status: Comment Closed				
615951	Biology/Ecology	Design Analysis	n/a	n/a	n/a
3. Ladder modifications. Two ft deep diffuser ☐ pools ☐ that exist in the lower ladder pose potential obstacles to lamprey passage. Some consideration should be given to adding grating flush with the ladder floor that would exclude most lamprey. (Submitted 06-Jul-04 by Christopher Peery cpeery@uidaho.edu 208 885-7223.)					
1-0	Evaluation Concurred This study didn't take lamprey passage into account and if they are to be considered at this point a change in scope might be necessary. Your comment is noted. (09-Jul-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Close Comment Closed without comment. (11-Aug-04 by Christopher Peery cpeery@uidaho.edu 208 885-7223).				
	Current Comment Status: Comment Closed				
592210	Design Team Leader	Design Memorandum or Report	Add an Acronym Page	after ii, before iii	n/a
recommend adding an acronym page to reference back and forth with (Submitted 15-Jun-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879.)					
1-0	Evaluation Concurred Acronym page added. (30-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Close Comment Closed without comment. (21-Jul-04 by Natalie Richards)				

	Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879).				
	Current Comment Status: Comment Closed				
592231	Design Team Leader	Design Memorandum or Report	Executive Summary	iii	n/a
1) 2nd sentence-Add commas after Specifically, the 2) 4th sentence- Add commas after In the BiOp, Operations 3)....by the end of 2003-May want to explain why this document is a year late. Were there funding, resource issues? 4) sentence starting Each report shall contain (a)..... and (c) recommendations for a need for structural changes... this is awkward. Possible re-write and (c)recommended structural changes is adequate..... (Submitted 15-Jun-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879.)					
1-0	Evaluation Concurred Punctuation added and item (c) reworded. (28-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Close Comment Closed without comment. (21-Jul-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879).				
	Current Comment Status: Comment Closed				
592239	Design Team Leader	Design Memorandum or Report	Executive Summary	iv	n/a
1st list- add submergence criteria- 8ft minimum (discuss at the end of the page) 2nd list- When tailrace levels are <11 ft (approximately....),- Add are and I think the ; is really a , 2nd list- spell out min. --> minimum 6th paragraph or list- clarify above 9. above elevation 9? Turbine 9? (Submitted 15-Jun-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879.)					
1-0	Evaluation Concurred - 8 ft minimum is in the first bullet so no later discussion should be needed.- The use of math symbols are probably confusing (>,<=) so they have been replaced with greater than, less than, and equal to where appropriate.- "minimum" has been spelled out. - 9 refers to the tailrace level ("ft" added to clarify). (28-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Close Comment Closed without comment. (21-Jul-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879).				
	Current Comment Status: Comment Closed				
592246	Design Team Leader	Design Memorandum or Report	Executive Summary	v, page 2, paragraph 1	n/a
1)Recommend being consistent throughout the document about the Phases (capitalize P)-...In addition, EC-HD..... worked on Phase 2 which pertains to field verification and fixing the numerical model to complete this Phase 1 work and Phase 3 which pertains to model enhancements 2) change be merged in to--> into (Submitted 15-Jun-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879.)					
1-0	Evaluation Concurred - "Phase" used throughout document. - "in to" changed to "into". (28-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				

1-1	Backcheck Recommendation Close Comment Closed without comment. (21-Jul-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879).				
	Current Comment Status: Comment Closed				
592249	Design Team Leader	Design Memorandum or Report	Section 1 Introduction	page 2, paragraph 1	n/a
2nd Phase--> Phase 2 3rd Phase--> Phase 3 (consistency throughout document) (Submitted 15-Jun-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879.)					
1-0	Evaluation Concurred "Phase #" now used throughout document (changed from "# phase") . (28-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Close Comment Closed without comment. (21-Jul-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879).				
	Current Comment Status: Comment Closed				
592322	Design Team Leader	Design Memorandum or Report	Section 2 Fishway System Features	page 4, pgrph 1, 3	n/a
7ft-3.5 in. spillbay 18 --> Spillbay 18 (Submitted 15-Jun-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879.)					
1-0	Evaluation Concurred Correction made throughout document. (28-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Open Comment Aside- The Spillbay 18 were corrected, but I found 2 occurrences of spill bay #23 change to Spillbay 23 to be consistent. NAR (21-Jul-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879).				
1-2	Backcheck Recommendation Close Comment Done (09-Aug-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835).				
	Current Comment Status: Comment Closed				
592342	Design Team Leader	Design Memorandum or Report	Section 2 Fishway System Features	page 5,	n/a
1)1st paragraph-2nd sentence needs a space ft high by15--> ft high by 15... 2)2nd paragraph- 7ft-3.5 in. 3)3rd paragraph- spill bay 18 --> Spillbay 18; spill bay --> spillbay; 3 ft-6.5 in (Submitted 15-Jun-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879.)					
1-0	Evaluation Concurred Corrections made. (28-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Open Comment 1) 2.2.1.1.1 Main Fixed Weir (SO-SG-2).....39.3 ft high by (add space) 15-feet 2) 3 ft(add -) 6.5 in (spell out inches). 3 ft-6.5 inches. (similar to page before 7 ft-3.5 inches (21-Jul-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879).				
1-2	Backcheck Recommendation Close Comment Done (09-Aug-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835).				

Current Comment Status: Comment Closed					
592372	Design Team Leader	Design Memorandum or Report	Section 2-2.2.2 Auxiliary Water Conduits	page 6 and 7	n/a
1) 4th sentence- Plate?? Add north arrows to Plate 2 and 3 2) 2nd to last page- From there, the flow 3) 2.2.2.1 Fish Valve 4-3...- 5th sentence- downstream end (weir 45)--> downstream end at weir 45. 4) 2.2.3 Overflow...- through 20, and to 40 ft--> through 20 to 40 ft 5) bullet 2- clarify "lower set" and "lower one" lower one measures? (Submitted 15-Jun-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879.)					
1-0	Evaluation Concurred 1) Reader referred to Plate 2. Plate 2 has north arrow. Added north arrow to Plate 3. 2) Punctuation added. 3) Change made to clarify. 4) Change made to clarify. 5) Text changed to clarify. (28-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Open Comment 1)Couldn't find N arrow on Plate 3?2) In general--> Is a capital W needed when a specific weir is listed?I am not sure. Recommend consistency throughout the document which ever way. Page 6? 2.2.2.1 Wier 45 OR 2.2.3 weirs 18 3) In general, need page numbers for the document (21-Jul-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879).				
1-2	Backcheck Recommendation Close Comment Done (09-Aug-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835).				
Current Comment Status: Comment Closed					
592422	Design Team Leader	Design Memorandum or Report	Section 3 Numerical Model	page 9	n/a
Paragraph 1- (forebay exit and ladder head control systems are not included in the simulation)--> So how is this accounted for in the model?? Is the water surface elevation specified? 3.1 Model Operations Last Paragraph- Once the BONNB command and file names are entered, the program is executed. An input screen appears... OROnce the BONNB command and file names are entered and the program is executed, an input screen appears.. (Submitted 15-Jun-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879.)					
1-0	Evaluation Concurred - The ladder flow is set by the head over the weir at the upstream end of the ladder. This is the 6 bullet item under the input parameter list. Text added to clarify. - Also added punctuation and text to sentence in 3.1 to clarify. (28-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Close Comment Closed without comment. (21-Jul-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879).				
Current Comment Status: Comment Closed					
592452	Design Team Leader	Design Memorandum or Report	Section 3 Numerical Model	page 10, 11	n/a
1st sentence-Once the desired settings are set in the input screen, the program last paragraph 1st sentence-what are the specific tolerances? +/- X cfs Bullet 2-can not --> cannot Bullet 3-The model uses a subprogram called Kentucky... This could be discussed on page 10 paragraph 1 with the introduction of KPIPE add comma-->However, we have been 3.3.1- 4th sentence-clarify					

why the ladder flow was not accounted for with respect to continuity. How much flow are we talking about here? (Submitted 15-Jun-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879.)

1-0 Evaluation **Concurred**
 -The specified tolerances are set by the user. The word user added to clarify. -Footnote added explaining KPIPE is Kentucky Pipe and explaining where it came from. -The exit section contributes about 100 to 120 cfs to the ladder (see table 3.2 and 3.3). A Branch and B Branch share an exit and therefore rather than duplicate measurements we used the measurements from the A Branch sampling for the B Branch calibration (the flow is set by the head over the weir which is a value that the ladder is operated for. The A branch data collection reports are referenced for the reader to follow up on if they choose to. (28-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)

1-1 Backcheck Recommendation **Open Comment**
 1) 3.2 5th bullet add comma-->rectangular. However (add,) we have 2) 3.3.1 Field Measurements, 1st paragraph, 3rd sentence.....continuity of flow, but in this case (add ,) the ladder flow (21-Jul-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879).

1-2 Backcheck Recommendation **Close Comment**
Done (09-Aug-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835).

Current Comment Status: **Comment Closed**

592497	Design Team Leader	Design Memorandum or Report	Section 3 Numerical Model-3.3.1. Field Measurement	page 12	n/a
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1st paragraph- starting at the 3rd sentence- change or add comma-->Also since the price meter orients in the direction of flow, it does not provide add comma and change to plane-->Therefore in the areas where flow is not approaching perpendicularly to the plain of data collection, the add comma--> As a result of both of these limitations, the price Paragraph 3- add comma--> For 7 Nov 2002 data collection, the..... add comma--> Consequently, errors.... (Submitted 15-Jun-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879.)

1-0 Evaluation **Concurred**
Punctuation added and spelling corrected. (28-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)

1-1 Backcheck Recommendation **Close Comment**
Closed without comment. (21-Jul-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879).

Current Comment Status: **Comment Closed**

592534	Design Team Leader	Design Memorandum or Report	Section 3 Numerical Model-3.3.2	page 12	n/a
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1. cross sectional area of the pipes do not represent equivalent cross section areas. They represent equivalent diameters.....Comment- These are completely different units. Cross section area is square feet and I think that equivalent diameter is in feet. Do the units come out correctly at the end?? If I have misunderstood the "equivalent", please clarify what this is in the report. (Submitted 15-Jun-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879.)

1-0 Evaluation **Concurred**
The program that simulates the AWS is a pipe network program (similar to EPANET). It assumes circular pipes and therefore it requires a pipe diameter as input. It then

	calculates form losses and friction losses based on that diameter. The "pipes" in our AWS are rectangular so the program has to be given values that are the circular equivalent. When NHC set up the program they based there pipe diameters on the hydraulic radius (or diameter in this case) of the rectangular conduits in order to provide the correct equivalent diameter for the Darcy-Weisbach equation but in so doing they are providing a diameter that doesn't give an equivalent cross-sectional area, which the program does automatically. Therefore, it isn't calculating form losses correctly. We changed it to get form losses correct because the form losses are more significant than friction losses in our system. I added text to clarify in the report. (29-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Close Comment Thanks for clarifying (21-Jul-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879).				
	Current Comment Status: Comment Closed				
592537	Design Team Leader	Design Memorandum or Report	Section 3 Numerical Model- 3.3.2	page 13	n/a
1st paragraph-add space Items 1 and 2 last sentence-Can't find the detailed modifications to the AWS system in Cy's report or do you have a seperate document that needs to be added. Items 3 and 4... so how did you run the program to complete Phase 1 work? Please clarify this in the text..... (Submitted 15-Jun-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879.)					
1-0	Evaluation Concurred - Added space - Cy's memo is the detail of modifications. He discusses modifications and or problems with the model throughout the memo. Table 3 summarizes coefficient and geometry changes but the reader is referred to the entire document for the detailed discussion of modifications. - The program was run on a computer with Windows 98 (disconnected from the network) and results for tailwaters exceeding 29.5 were extrapolated. This is noted where the results and recommended operations are presented. (Plate 6 for example). Text has been added to explain the impacts of item 3 and 4 on this evaluation. (29-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Close Comment Closed without comment. (21-Jul-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879).				
	Current Comment Status: Comment Closed				
592538	Design Team Leader	Design Memorandum or Report	Section 3 Numerical Model- 3.3.3	page 14	n/a
Title- model --> Model Main Fixed Weir 2nd, 3rd line and throughout the table- h1/p should the 1 be a subscript? Side Weir Slot and Sluice Gates- 5th and 4th lines respectively Valuse --> Values (Submitted 15-Jun-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879.)					
1-0	Evaluation Concurred - h1/p changed to be consistent with Cy's notation in Appendix A (subscript added). - Typo has been corrected. (29-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Close Comment Closed without comment. (21-Jul-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879).				

Current Comment Status: Comment Closed					
592549	Design Team Leader	Design Memorandum or Report	Section 3 Numerical Model- 3.3.3	page 15	n/a
Can't find the comparison between the field measurement and model, original and revised etc... Is this a seperate document or within Cy's report? 2nd paragraph- add comma- As stated earlier, the expected 3rd paragraph- 7 ft- 3.5 in Bullets- add periods, clarify equivalent head in the 3rd bullet--> The model underestimates AWS flow rates at equivalent head. (Submitted 15-Jun-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879.)					
1-0	Evaluation Concurred - The comparisons are made in Table 3.2 and Table 3.3. - Punctuation added (29-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Open Comment 3.3.3 3 paragraph change 7-ft 3.5 inches to 7 ft-3.5 inches Did not incorporate "Total Entrance flow rates within 30%" Is that okay? add period after bullet ending 25%. add period after bullet ending equivalent head. (21-Jul-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879).				
1-2	Backcheck Recommendation Close Comment Inches taken care of. I removed the note about the 30% on purpose. I thought it was information you could get by looking at the table directly and didn't need to be pointed out in a little side note. (09-Aug-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835).				
Current Comment Status: Comment Closed					
592555	Design Team Leader	Design Memorandum or Report	Section 3 Numerical Model- 3.3.3	page 16- Tables 3.2, 3.3	n/a
Earlier in the report, the ladder flow was not accounted for in the model (section 3.3.1) then it was verified here??? This is confusing, please clarify. add - 7'- 3.5 " (Submitted 15-Jun-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879.)					
1-0	Evaluation Concurred -The ladder flow was accounted for just not measured during the B Branch data collection. The ladder flow was measured during the A branch data collection (A and B have a common exit). The ladder flows measured during the A Branch collection where used to interpolate for the B Branch conditions and compared to the model. - Corrections made to Table 3.2 (29-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Close Comment Closed without comment. (21-Jul-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879).				
Current Comment Status: Comment Closed					
592562	Design Team Leader	Design Memorandum or Report	Section 3 Numerical Model- 3.3.4	page 17	n/a
2nd sentence-add--> adult fish criteria found on page iv. Sentence.... See Appendix A (add page 16) for further..... The program changes in Cy's report relate to coefficients not geometry which is how the paragraph started off?! (Submitted 15-Jun-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879. Revised 15-Jun-04.)					

1-0	Evaluation Concurred -Text added. - The program changes in Cy's report relate to coefficients and geometry (see Table 3 of Cy's memo). For example the diameter issue for the closed conduit program is a coefficient and geometry issue. (29-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Close Comment Closed without comment. (21-Jul-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879).				
Current Comment Status: Comment Closed					
594612	Design Team Leader	Design Memorandum or Report	Section 4 Fishway Evaluation	page 19	n/a
1)Adult Fish Criteria- this is stated on Page 19 and iv and they are almost the same but not quite. With the addition of the submergence on page iv, then page 19 needs Elevation entrance weir.... Recommend consistency. 2) 3rd paragraph- Suggest rewrite for easier reading-The first sentence could read ... According to Bonneville Dam Design Memorandum (DM) No. 1, Modification for Peaking [4], the AWS system is to be operated at no more than 5 pounds per square inch (psi), which enables juveniles to pass (list obstacles)without sustaining significant injury. Therefore, 5 psi +/-1 psi will be added to the criteria above. 3) Last paragraph- Drawing BDF-9-6-OAO/1 shows the current operational plan for the fishway including a list of diffusers... (I would add this drawing to the Appendix also (Submitted 16-Jun-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879.)					
1-0	Evaluation Concurred - Made executive summary criteria consistent with those found in Section 4.1. - Text modified. - Information from BDF-9-6-OAO/1 is summarized in Plate 5. The following sentence states this. (29-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Open Comment add a comma 4.1, 2nd paragraph, last sentence.... Therefore (add ,) the 4 to 6 psi.... (21-Jul-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879).				
1-2	Backcheck Recommendation Close Comment Done (09-Aug-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835).				
Current Comment Status: Comment Closed					
594695	Design Team Leader	Design Memorandum or Report	Section 4 Fishway Evaluation	page 20	n/a
1) 1st paragraph- spill bay--> spillbay (Recommend consistency throughout the report whether is spill bay or spillbay) 2) 1st paragraph, last sentence--> add comma between ladder and the. flow for the ladder, the side entrances is to be kept closed permanently. 3)4.2 Evaluation Procedures, 1st paragraph, sentence 3, add comma after Specifically, model runs..... 4) 4.2 Evaluation Procedures, 1st paragraph,last sentence- Conclusion are not in Section 4.1 (Operational Criteria)?? Do you mean Section 5?? 5) 4.2 Evaluation Procedures, 2nd paragraph, 2nd sentence- suggest rewrite.. from 7 ft to 29 ft NGVD with a forebay of 74.5 ft. 6) 4.3.1 add comma According to model simulations, the current 7) fails to meet 1.5 ft/s channel velocity--> How far is it out? Is this information on Table 4.1? (Submitted 16-Jun-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879.)					
1-0	Evaluation Concurred 1) Changed throughout document for consistency. 2, 3, 6) Punctuation added. 4) Reader referred to Section 4.3.1 rather than 4.1. 5) Text changed. 7) Depending on the tailwater, the channel velocity can be low by as much as 0.5 ft/s. Actual values are provided in				

	Table 4.1. (30-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Open Comment 3)4.2 Evaluation Procedures, 1st paragraph, sentence 3, add comma after Specifically (add ,) model runs..... (21-Jul-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879).				
1-2	Backcheck Recommendation Close Comment Done (09-Aug-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835).				
	Current Comment Status: Comment Closed				
594737	Design Team Leader	Design Memorandum or Report	Section 4 Fishway Evaluation	page 21, Table 4.1	n/a
0) Find the Sheet BDF-9-6-0A0/1 confusing with respect to page 19 thelast paragraph. Is this a figure or a sheet. Either page 19 needs a different figure number or Table 4.1 needs to be renamed. Please clarify 1) Add Tailwater Elevation in NGVD 1.5) Add space after @ FG3-28 2) Some text is centered, some is right justified--> recommend consistency 3) Change znd to and 4) Add comma after--> At higher forebays, the ladders ability.... (Submitted 16-Jun-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879.)					
1-0	Evaluation Concurred 0) Table 4.1 is not titled "Sheet BDF-9-6-0A0/1" the title of the Tables is "Operation in Accordance with Fish Passage Plan and Updated Operations Sheet BDF-9-6-0A0/1" - Table changed to include "Tailwater elevation" and modified to clarify purpose. Also corrected punctuation and added spaces where appropriate. (30-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Open Comment Can't find BDF-9-6-OAO/1 in the report? recommend providing it. 4) Add comma after--> At higher forebays (add ,) the ladders ability.... (21-Jul-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879).				
1-2	Backcheck Recommendation Close Comment Did not include BDF-9-6-OAO/1 in report. It is something we got from the project and is confusing (that is why we summarize it in Plate 5). I think not including it and referencing it is adequate. (09-Aug-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835).				
	Current Comment Status: Comment Closed				
594794	Design Team Leader	Design Memorandum or Report	Section 4 Fishway Evaluation	page 21	n/a
1) Sentence starting with ...Unfortunately is awkward with too many "while"s, Add elevation 9... elevation 16 May be break into two sentences Unfortunately, when an entrance is closed..... (remove parenthesis) desired entrance head. This occurs while the entrance channel depth is increased (remove parenthesis) with the increasing tailwater (Submitted 16-Jun-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879.)					
1-0	Evaluation Concurred Text added to clarify. (29-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Open Comment please clarify greater than 9.... and levels greater than 16... greater than 9 feet? OR greater than elevation 9? greater than 16 feet OR greater than elevation 16? (21-Jul-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879).				

1-2	Backcheck Recommendation Close Comment Tailrace levels (or elevations) are in feet. Feet added to clarify. (09-Aug-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835).				
	Current Comment Status: Comment Closed				
594885	Design Team Leader	Design Memorandum or Report	Section 4 Fishway Evaluation, 4.3.1	page 22	n/a
1st paragraph- 1) 2nd sentence- add comma....flow capacity, the desired head at the entrance.... 2) 3rd sentence- add comma.....desired velocities, the entrance head.. 3) 4th sentence- suggest rewrite....In the Cascade Island Fishway, the third criteria, 5 psi +/- 1 psi, is compromised... 4) Last Sentence-add comma... Therefore, only the entrance.... (Submitted 16-Jun-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879.)					
1-0	Evaluation Concurred Punctuation added and text modified. (29-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Open Comment Sentence before 4.3.2 4) Last Sentence-add comma... Therefore (add .) only the entrance.... (21-Jul-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879).				
1-2	Backcheck Recommendation Close Comment Done (09-Aug-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835).				
	Current Comment Status: Comment Closed				
594979	Design Team Leader	Design Memorandum or Report	Section 4 Fishway Evaluation, 4.3.2	page 22	n/a
1) The first sentence is confusing or long. ...(the conflicting constraints place by the entrance head and channel velocity) (the conflicting constraints of entrance head and channel velocity),the model..... OR Move second sentence to the first sentence... The primary problem with the current system is that by closing the side entrance...entrance head differential. After identifying this limitation, the model was used to find alternative ladder operations..... 2) don't think you need ,and; just a ,--> channel velocity can be maintained, 2)that more flow be provided.... 3)last sentence.... schedule though, and therefore, an alternate operations... 4) second bullet....entire entrance channel. (The old fish..... (Submitted 16-Jun-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879.)					
1-0	Evaluation Concurred 1) Punctuation added. 2) text deleted to clarify. 3) Sentenced kept as is because portion about "the old fish lock diffusers is not relevant by itself it is a secondary point to the statement about the diffuser priorities in the sentence it is located. (29-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Close Comment Closed without comment. (21-Jul-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879).				
	Current Comment Status: Comment Closed				
595076	Design Team Leader	Design Memorandum or Report	Section 4 Fishway Evaluation, 4.3.2	page 23	n/a
1) Suggest...elevation if the upstream weir of the diffuser's pool,i.e., FG3-27....exceeding					

elevation 9 ft (the elevation of the downstream pool weir) rather than elevation 10.5 ft as called for under the current plan. Also,..... 2)To be consistent... the entrance diffusers FG4-29-FG4-33 were opened and operated... 3) second bullet... once the south sluice gate is closed, channel velocities..... above the minimum criteria of 1.5 ft/sec (remove the parenthesis) 4) 3rd and 4th bullets- (remove the parenthesis to be consistent) The second sluice gate SG-3N can be kept open..... above the minimum entrance criteria of 1 foot. Once the second sluice gate is closed, the minimum channel velocity can no longer (add be) met. 5)..... highest tailwater levels of 34-35 ft. 6) May not need to repeat,suggest.....As stated above, the alternative operation scheme keeps the sluice gates open longer and brings the ladder diffusers on line as soon... 7) remove parenthesis- 2nd sent The curren (Submitted 16-Jun-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879.)

1-0	Evaluation Concurred -Text changed -(FG4-29 through FG4-33) is consistent with the bulleted items above and less confusing than FG4-29-FG-33 (looks like one large reference or a drawing). - Parenthesis removed -Text added (29-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)
1-1	Backcheck Recommendation Open Comment 1)add comma Once the second sluice gate is closed (add ,) the minimum channel velocity 4.3.2, 4th bullet, last sentence- minimum criteria (1.5 ft/sec) possible change to minimum criteria of 1.5 ft/sec. (21-Jul-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879).
1-2	Backcheck Recommendation Close Comment Done (09-Aug-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835).
Current Comment Status: Comment Closed	

595104	Design Team Leader	Design Memorandum or Report	Section 4 Fishway Evaluation, 4.3.2	page 23	n/a
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1)In general remove paranthesis ... In addition to bringing the ladder diffusers FG64-29 through FG4-28 on line at lower tailwater levels, the entrance channel diffusers FG64-29 (add a space) through FG4-33..... 2) second to last sentence- sluice gate is closed at a tailwater of elevation 27 ft and the second(add gate) will.. 3) can't to cannot (Submitted 16-Jun-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879.)

1-0	Evaluation Concurred Text changed to clarify. (29-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)
1-1	Backcheck Recommendation Close Comment Closed without comment. (21-Jul-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879).
Current Comment Status: Comment Closed	

595155	Design Team Leader	Design Memorandum or Report	Section 4 Fishway Evaluation, 4.3.2	page 24, Table 4.2	n/a
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1) Tailwater (add Elevation) (ft) 2) Column Change in Entrance AWS (psi)-some values are less than 4 psi. Isn't the criteria 5 psi +/- 1 psi--> 4 to 6 psi. Need shading?? 3) Column Max Diffuser Velocities-all values are over the 0.5 ft/second criteria page iv. Need shading?? May consider adding the criteria somehow so the reader does not have to flip back and forth (Submitted 16-Jun-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879.)

1-0	Evaluation Concurred Table changed to better present results. (29-Jun-04 by Kyle McCune
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	Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Close Comment Closed without comment. (21-Jul-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879).				
	Current Comment Status: Comment Closed				
596250	Design Team Leader	Design Memorandum or Report	Section 5: Recommendations	Page 25	n/a
1. add comma and the--> In general, the program code should be revised to remove hard.... 3. Don't think a ,and is needed between a. and b. Bullet 1- GUI stands for ?? Graphic User Interface? please define Last sentence is awkward- possible rewrite- Ultimately, the program would generate a ladder system drawing with all of the respective characteristics defined, i.e., diffuser locations, flow rates..... (Submitted 16-Jun-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879.)					
1-0	Evaluation Concurred Punctuation added and text changed to clarify. (29-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Open Comment 5.1 Last bullet add comma, "the" or "a" Ultimately (add ,) model results could be displayed on a drawing of (the) or (a) ladder system... (21-Jul-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879).				
1-2	Backcheck Recommendation Close Comment Done (09-Aug-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835).				
	Current Comment Status: Comment Closed				
596289	Design Team Leader	Design Memorandum or Report	Section 5: Recommendations, 5.3	Page 26	n/a
1)Second sentence- remove () (From long ago, I remember that anything in()is not necessary/mandatory to the understanding of a sentence. So if it is mandatory, it should not have()around it. If this is not the current rational, please disregard all remove()remarks 2)5.3 Fishway Structural Modifications-add a comma after implemented, the ladder system.... remove ()if necessary/mandatory to understanding 3) Picket leads at old fish lock... paragraph Would the recommended picket lead installation in any way deter fish from coming into the ladder? 3.5) last sentence- tailwater levels, and therefore, more extensive 4)Entrance modifications: tailwater is under elevation 9. And clarify the highest tailwater. (Submitted 16-Jun-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879. Revised 16-Jun-04.)					
1-0	Evaluation Concurred 1) () - denotes something that is not necessary or mandatory to what the sentence is conveying but is something that can help convey the message. I use them to encapsulate a though that may help convey the idea I am trying to get across (often an example of what I am stating in the sentence). This is similar to encapsulating a statement in commas. I did get rid of a few parenthesis because they were confusing the sentence but for the most part I kept the parenthesis. 2) Punctuation added 3) The picket leads would stop the fish from approaching the fish locks, which is an area of the ladder bios don't want them. The increased flow from the fish lock diffusers might confuse fish but is a question for a bio and something to be addressed when we get to feasibility or design. 4) Text added to clarify (29-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Open Comment				

	1) 5.3 Fishway Structural Modifications-.....Section 4.3.2 is implemented (add ,) the ladder system.... 2)5.3 Fishway Structural Modifications-Entrance modifications: tailwater is under (add elevation) 9. OR....tailwater is under 9 (add feet). (21-Jul-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879).				
1-2	Backcheck Recommendation Close Comment Done (09-Aug-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835).				
	Current Comment Status: Comment Closed				
596334	Design Team Leader	Design Memorandum or Report	5.3 Fishway Structural Modifications	Page 27	n/a
1)1st sentence start with....Alternative A would be to..... 2)Last sentence 1st full paragraph ...channel velocities in the entrance channel and (change give to provide) better control of the entrance head 3)1st sentence, second paragraph start with- Alternative B replaces the sluice.... 4)Replace two with 2-10 ft modulating weirs; 2.3 ft to 28.0 ft (significant digits are the same?) 5) 2nd sentence is awkward, possible rewrite....tailwater ranges, but because the weir (replace it with the weir)is operated at 8 ft submergence, it (add comma it) fails to meet..... 6) ...would have a minimum sill height of 2.3 ft instead of the existing 6.0 ft. (delete sill) 7) Alternative C? (third alternative) 8)4th paragraph-Though both..... at the entrances (add comma), there still may be... 9)4th pg, last sent- possible rewrite..More analysis is necessary to determine the feasibility of entrance modifications for Bradford Island B Branch. (Submitted 16-Jun-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879.)					
1-0	Evaluation Concurred Text modified and punctuation added to clarify. (29-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Open Comment 1) done 2) Take out "give" 3) done 4) not done but not important 5) lower tailwater ranges (change position of comma,) but 6) not done but make sense to keep it 7) done 8) comma needed after ...Though these alternatives would provide more control at the entrances (add,) there still may.... Also, I like Even though better then Though but this is up to you. 9) done (21-Jul-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879).				
1-2	Backcheck Recommendation Close Comment Done. (09-Aug-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835).				
	Current Comment Status: Comment Closed				
596348	Design Team Leader	Design Memorandum or Report	5.3 FSM- Larger Structural Options	Page 28	n/a
1. having "supply" in the sentence makes is read awkwardly. If conservation of water was place at a premium, then...?? 2) remove ()??? 3) 2. conflicting minimums 8-foot min or 7-foot min 4) Thus, the option... 5) change from... to at least -1 elevation to at least elevation -1. 6) remove --...weirs -- as described to... weirs as described.... (Submitted 16-Jun-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879.)					
1-0	Evaluation Concurred - "supply" removed - parenthesis kept - 7 ft removed - elevation text changed - "--" removed (29-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Close Comment Closed without comment. (21-Jul-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879).				

Current Comment Status: Comment Closed					
596349	Design Team Leader	Design Memorandum or Report	Table 4.2	Page 24	n/a
Add Forebay elevation into table. (Submitted 16-Jun-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879.)					
1-0	Evaluation Concurred Table modified to include forebay elevation in title. (29-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Close Comment Closed without comment. (21-Jul-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879).				
Current Comment Status: Comment Closed					
597255	Design Team Leader	Design Memorandum or Report	Exec. Summary vs Section 5.3	iv, Page 26-27	n/a
Last comment There are several recommendations back in Section 5.3 that are not included in the Executive Summary- Entrance modifications-Alternatives A,B,C. Larger Structural Options- Recommend bringing those ideas back to page iv in a brief statement (don't need all the detail thats provided on Page 26-27). (Submitted 17-Jun-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879.)					
1-0	Evaluation Concurred We only put one of the entrance modification alternatives in the executive summary as the most likely one to pursue. Alternative B was noted in Section 5 but the then it was recommended it not be pursued further. I added a little blurb about Alternative C to the executive summary. The structural changes aren't bulletized but they are in the paragraph below the entrance modifications. (30-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Close Comment Closed without comment. (21-Jul-04 by Natalie Richards Natalie.A.Richards@nwp01.usace.army.mil (503) 808-4879).				
Current Comment Status: Comment Closed					
572350	Hydraulics	Design Memorandum or Report	Page iii	n/a	n/a
Capitalize "The Dalles" (Submitted 25-May-04 by Randy Lee Randall.T.Lee@nwp01.usace.army.mil (503) 808-4876.)					
1-0	Evaluation Concurred Corrected throughout document. (22-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Close Comment Closed without comment. (19-Jul-04 by Randy Lee Randall.T.Lee@nwp01.usace.army.mil (503) 808-4876).				
Current Comment Status: Comment Closed					
572356	Hydraulics	Design Memorandum or	Page v	n/a	n/a

		Report			
"Phase" should be capitalized. (Submitted 25-May-04 by Randy Lee Randall.T.Lee@nwp01.usace.army.mil (503) 808-4876.)					
1-0	Evaluation Concurred Corrected throughout document. (28-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Close Comment Closed without comment. (19-Jul-04 by Randy Lee Randall.T.Lee@nwp01.usace.army.mil (503) 808-4876).				
	Current Comment Status: Comment Closed				
572358	Hydraulics	Design Memorandum or Report	Page v	n/a	n/a
"Phase" should be capitalized. (Submitted 25-May-04 by Randy Lee Randall.T.Lee@nwp01.usace.army.mil (503) 808-4876.)					
1-0	Evaluation Concurred Corrected throughout document. (28-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Close Comment Closed without comment. (19-Jul-04 by Randy Lee Randall.T.Lee@nwp01.usace.army.mil (503) 808-4876).				
	Current Comment Status: Comment Closed				
572360	Hydraulics	Design Memorandum or Report	Page 1 Para. 1 and numerous	n/a	n/a
Change "Cascade" to "Cascades". (Submitted 25-May-04 by Randy Lee Randall.T.Lee@nwp01.usace.army.mil (503) 808-4876.)					
1-0	Evaluation Concurred Corrected throughout document. (28-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Close Comment Closed without comment. (19-Jul-04 by Randy Lee Randall.T.Lee@nwp01.usace.army.mil (503) 808-4876).				
	Current Comment Status: Comment Closed				
572366	Hydraulics	Design Memorandum or Report	Page 2	n/a	n/a
Change "1st phase, 2nd phase and 3rd phase" to "Phase 1, Phase 2 and Phase 3" to be consistent with page v para. 1 (Submitted 25-May-04 by Randy Lee Randall.T.Lee@nwp01.usace.army.mil (503) 808-4876.)					
1-0	Evaluation Concurred Correction made. (28-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Close Comment Closed without comment. (19-Jul-04 by Randy Lee Randall.T.Lee@nwp01.usace.army.mil (503) 808-4876).				

	(503) 808-4876).				
	Current Comment Status: Comment Closed				
572391	Hydraulics	Design Memorandum or Report	Sec 2.1 para. 1, 1st sent.	n/a	n/a
for consistency either use "fishway" or "fishladder". See Section 1 1st para. where this structure is also calle B-Branch Fishladder. (Submitted 25-May-04 by Randy Lee Randall.T.Lee@nwp01.usace.army.mil (503) 808-4876.)					
1-0	Evaluation Concurred "Fishway" will be used to refer to the entire B Branch system and and "fishladder" will be used when referring to the overflow weir portion. (28-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Close Comment Closed without comment. (19-Jul-04 by Randy Lee Randall.T.Lee@nwp01.usace.army.mil (503) 808-4876).				
	Current Comment Status: Comment Closed				
572395	Hydraulics	Design Memorandum or Report	Page 4, Sec. 2.2.1.1	n/a	n/a
"Spillbay 18" is capitalized here by not in Sec. 2.2.1. (Submitted 25-May-04 by Randy Lee Randall.T.Lee@nwp01.usace.army.mil (503) 808-4876.)					
1-0	Evaluation Concurred Spillbay capitalized when referring to a specific spillbay. (28-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Close Comment Closed without comment. (19-Jul-04 by Randy Lee Randall.T.Lee@nwp01.usace.army.mil (503) 808-4876).				
	Current Comment Status: Comment Closed				
572397	Hydraulics	Design Memorandum or Report	Page 12, para. 1	n/a	n/a
Capitalize "price" in "Price meter". (Submitted 25-May-04 by Randy Lee Randall.T.Lee@nwp01.usace.army.mil (503) 808-4876.)					
1-0	Evaluation Concurred "Price Meter" inserted throughout document. (28-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Close Comment Closed without comment. (19-Jul-04 by Randy Lee Randall.T.Lee@nwp01.usace.army.mil (503) 808-4876).				
	Current Comment Status: Comment Closed				
572401	Hydraulics	Design Memorandum or Report	Page 12, para. 2	n/a	n/a
Spell out ADV before abbreviating it. (Submitted 25-May-04 by Randy Lee Randall.T.Lee@nwp01.usace.army.mil (503) 808-4876.)					

1-0	Evaluation Concurred Correction made. (28-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Close Comment Closed without comment. (19-Jul-04 by Randy Lee Randall.T.Lee@nwp01.usace.army.mil (503) 808-4876).				
	Current Comment Status: Comment Closed				
572405	Hydraulics	Design Memorandum or Report	Page 13 #3	n/a	n/a
May want to come up with a substitute word(s) for "hardwired". Readers who are not familiar with computer programming may not know what this term means. (Submitted 25-May-04 by Randy Lee Randall.T.Lee@nwp01.usace.army.mil (503) 808-4876.)					
1-0	Evaluation Concurred "hardwired" changed to "hard coded". Explanation of "hard coded" added as a footnote at this location. (28-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Close Comment Closed without comment. (19-Jul-04 by Randy Lee Randall.T.Lee@nwp01.usace.army.mil (503) 808-4876).				
	Current Comment Status: Comment Closed				
572416	Hydraulics	Design Memorandum or Report	Page 20 Sec. 4.2	n/a	n/a
Substitute word(s) for "hard coded". (Submitted 25-May-04 by Randy Lee Randall.T.Lee@nwp01.usace.army.mil (503) 808-4876.)					
1-0	Evaluation Concurred Definition added as a footnote to earlier occurrence of term. (28-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Close Comment Closed without comment. (19-Jul-04 by Randy Lee Randall.T.Lee@nwp01.usace.army.mil (503) 808-4876).				
	Current Comment Status: Comment Closed				
572420	Hydraulics	Design Memorandum or Report	Table 3.1 Side Weir Slot Submerged Weir Eq.	n/a	n/a
Correct "values" (Submitted 25-May-04 by Randy Lee Randall.T.Lee@nwp01.usace.army.mil (503) 808-4876.)					
1-0	Evaluation Concurred Correction made. (28-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Close Comment Closed without comment. (19-Jul-04 by Randy Lee Randall.T.Lee@nwp01.usace.army.mil (503) 808-4876).				
	Current Comment Status: Comment Closed				

572423	Hydraulics	Design Memorandum or Report	Table 3.1 Sluice Gates Submerged Weir Eq.	n/a	n/a
Correct "values". (Submitted 25-May-04 by Randy Lee Randall.T.Lee@nwp01.usace.army.mil (503) 808-4876.)					
1-0	Evaluation Concurred Correction made. (28-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Close Comment Closed without comment. (19-Jul-04 by Randy Lee Randall.T.Lee@nwp01.usace.army.mil (503) 808-4876).				
	Current Comment Status: Comment Closed				
572426	Hydraulics	Design Memorandum or Report	Page 25	n/a	n/a
"GUI" should be spelled out first. (Submitted 25-May-04 by Randy Lee Randall.T.Lee@nwp01.usace.army.mil (503) 808-4876.)					
1-0	Evaluation Concurred GUI defined. (28-Jun-04 by Kyle McCune Kyle.C.McCune@nwp01.usace.army.mil (503) 808-4835)				
1-1	Backcheck Recommendation Close Comment Closed without comment. (19-Jul-04 by Randy Lee Randall.T.Lee@nwp01.usace.army.mil (503) 808-4876).				
	Current Comment Status: Comment Closed				

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